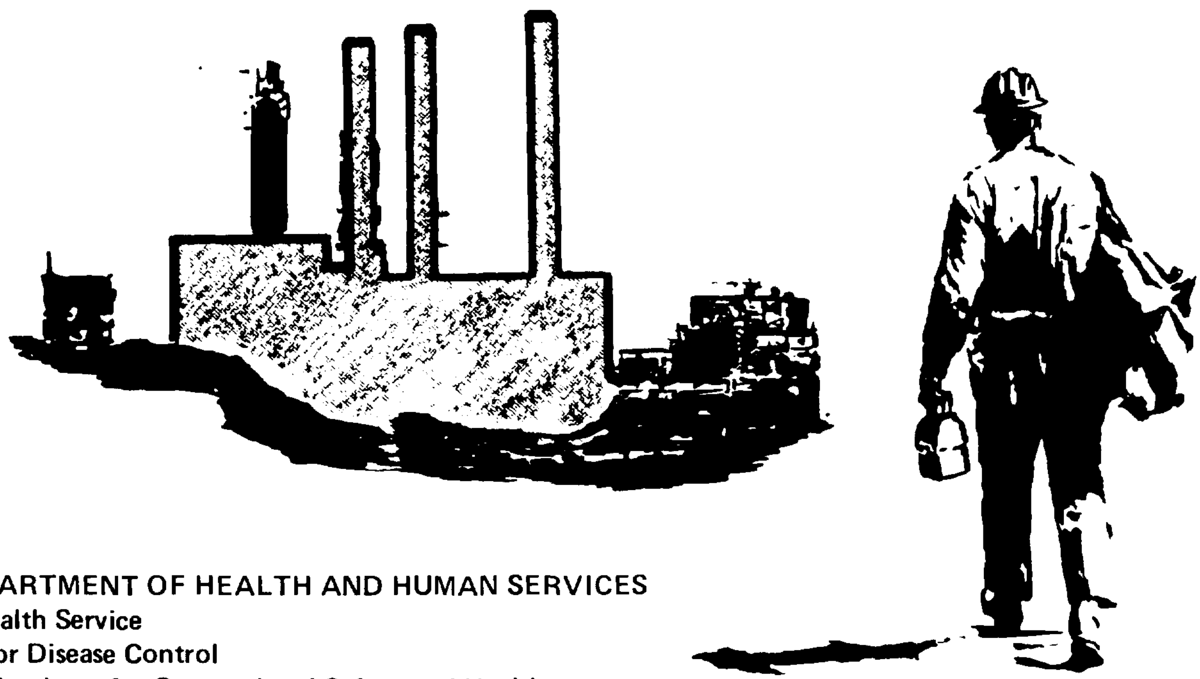
NIOSH

OCCUPATIONAL HAZARD ASSESSMENT

Criteria for Controlling Occupational Hazards in Animal Rendering Processes



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

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PREFACE

In 1977, the national injury rate for workers in rendering plants was reported to be almost twice that reported for the manufacturing industries sector. The need to assess and identify the underlying causes of this high rate and provide recommendations to reduce the incidence of these injuries prompted the National Institute for Occupational Safety and Health (NIOSH) to survey rendering plants and assess the occupational hazards of the rendering process. This document critically reviews the scientific and technical information concerning mechanical injury, physical agents (eg, noise, heat), and biological and chemical agents in the rendering workplace. Chapter III of this document, entitled Health and Safety Guidelines, is provided so individuals immediately responsible for hazard control in their specific workplace will have a basis on which to formulate their own occupational safety and health program. Employer knowledge of and adherence to these guidelines will reduce adverse effects on worker safety and health. This document is also intended for use by unions, industrial trade associations, and scientific and technical investigators to further their own objectives in providing for a safer workplace. Furthermore, it is intended to assist the Occupational Safety and Health Administration, US Department of Labor, in its standards development and compliance activities.

Contributions to this document by NIOSH staff, other Federal agencies or departments, the review consultants, the National Renderers Association, and The United Food and Commercial Workers are gratefully acknowledged.

The views and conclusions expressed in this document, together with the recommendations, are those of NIOSH. They are not necessarily those of the consultants, the reviewers selected by professional societies, or other Federal agencies. However, all comments, whether or not incorporated, have been carefully considered.

Ronald F. Coene

Ronald F. Coene, P.E.
Acting Director
National Institute for Occupational Safety and Health

SYNOPSIS

This document reviews information on occupational hazards associated with the rendering of animal material and recommends guidelines for preventing injury and illness in rendering plant workers. The major hazards in rendering plants result in mechanical injury; they include wet and slippery surfaces, lifting, pushing, and pulling large and heavy containers and carcasses, skinning, hide trimming, gutting and boning dead stock, and the moving parts of process equipment to which workers may be exposed. Burns may result from contact with boilers, cooking vats, and steam and hot water lines. Heat stress may result from excessive exposure to heat generated by process equipment. Exposure to nuisance dust, excessive noise, and electrical shock also occurs.

When processes do not effectively confine fat mist, rendering operations are especially vulnerable to fire, which may result from electrical short circuits and from maintenance operations such as welding and cutting. Materials in percolation (perc) pans may also spontaneously ignite and cause fires if they are not processed promptly.

Infections resulting from organisms associated with animal material occur occasionally. Workers may also be exposed to chemicals generally associated with cleanup or maintenance activities. Under certain conditions, hazardous gases can be generated by anaerobic reactions during the holding of accumulated organic raw materials.

Rendering facilities are of two types, those directly associated with meatpacking and poultry slaughtering and dressing operations (onsite) and those that are independent of these operations. There are approximately 3,000 workers associated with onsite rendering facilities and about 9,000 workers associated with independent rendering facilities in the United States. Rendering processes are classified according to whether inedible or edible products are produced. The major inedible fat products are grease and inedible tallow; major inedible protein meal products are meat meal and meat-and-bone meal. Edible products include lard, edible tallow, and certain proteinaceous tissues.

Based on information from the available literature, reviewer comments, and plant site visits, NIOSH recommends guidelines for engineering controls and work practices to reduce the number of injuries and illnesses in rendering plants. Recommendations for training, posting, personal protective equipment programs, medical surveillance, and maintenance of relevant records are also included.

ACKNOWLEDGEMENTS

The Division of Criteria Documentation and Standards Development, NIOSH, had primary responsibility for the development of this document and guidelines for the rendering of animal material. Martin N. Erlichman and Michael C.R. Alavanja, Dr. P.H., of this Division served as criteria managers.

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CONTENTS (CONTINUED)

I. PLANT AND PROCESS DESCRIPTIONS FOR THE RENDERING OF ANIMAL MATERIALS

Background and Scope of Document

The rendering of animal materials was one of the first recycling industries. It began about 150 years ago, and grew as the meat products industry grew. Many new uses were found for products derived from materials such as grease, hair, blood, feathers, hides, and bones [1]. Products from rendering operations are either inedible or edible; inedible products include inedible tallow and grease and various protein meals such as blood meal, feather meal, meat meal, bone meal, and meat-and-bone meal. Edible products include lard, edible tallow, and protein tissue [1].

Rendering performed at meatpacking or poultry dressing plants is referred to as onsite, or captive, rendering. Onsite renderers produce almost all of the edible lard and edible tallows made. Rendering not performed at meatpacking or poultry dressing plants is referred to as offsite, or independent, rendering. According to the Census of Manufactures, the independent rendering industry accounted for 69% of the inedible tallow and grease in 1977 [2]. This Census reported that 500 establishments were classified under Animal and Marine Fats and Oils (SIC code 2077); about 450 of these rendered animal materials. The number of workers at onsite rendering facilities (SIC codes 2011 and 2016) was estimated to be about 3,000 (A Phifer, written communication, June 1978). The National Renderers Association has estimated that half of the 9,000 workers employed by independent rendering plants are involved in plant operations and maintenance (WH Prokup, written communication, February 1981). Table I-1 summarizes production figures for the rendering industry [3].

This document concerns occupational exposure in the manufacture of rendered animal products, particularly the handling and processing of raw materials at the rendering plant as well as maintenance, cleanup, and repair work. The collection of raw materials from butcher shops, supermarkets, restaurants, farms, and meatpacking plants is not a part of the rendering production process, and is not discussed here. The guidelines in Chapter III apply to both onsite and independent rendering.

Inedible Rendering

Raw materials for independent inedible rendering come from a variety of sources, including butcher shops, restaurants, grocery stores, feedlots, and meatpacking plants [4]. The raw materials are usually bones and bone fragments, offal, blood, feathers, other cut-up materials, and barrels of restaurant grease. This material, usually delivered in barrels or by a dump truck, is weighed, evaluated for potential endproducts, and dumped into receiving pits or bins. The trucks and barrels are hosed out and the washings are emptied into an adjacent pit and drained into an onsite waste-treatment system. Separated solids are recycled into the receiving pits. Some independent rendering plants also process dead stock. Plants without mechanized pre-breakers and crushers that can process whole dead animals must have the carcasses cut up with axes or knives by plant personnel. This is done either with the animal lying on the floor or hanging from an overhead rail.

TABLE I-1

RENDERING INDUSTRY PRODUCTION DATA FOR 1979

Products	Million Pounds	Metric Tons
Inedible Tallow and Grease	5,900	(2,681,550)
Edible Tallow	1,550	(704,475)
Lard	1,280	(581,760)
Meat and Bone Meal and Tankage	4,680	(2,127,060)
Feather Meal	790	(359,055)

Adapted from reference 3

The raw material in the receiving pit is then crushed or ground to the size necessary for cooking or moisture evaporation [4]. To limit the production of odor and to maintain product quality of the tallow or grease and protein meal, raw material is usually processed promptly. Size reduction operations use equipment such as pre-breakers, shredders, grinders, and hashers. Following the size reduction step the raw material is sent on to cookers which can either be a batch or continuous type [4]. Figure I-1 is a generalized flow diagram of this process. Figure I-1 also shows ancillary processes which are discussed later.

Onsite rendering operations in meatpacking and poultry dressing plants usually receive raw materials directly from the kill floor. If the rendering operation is in a separate building on the same premises, the raw material is moved by pump or truck to the cookers. At this point the onsite and offsite rendering processes are similar [1].

(a) Batch Cooker Processing

Moisture is evaporated and fats are released from the raw material by heating it under controlled conditions [1,4]. A quantity of material is cooked in batch cookers to a specified moisture or temperature, and then the load is discharged. Figure I-2 is a generalized diagram of a batch cooking system [4].

Dry-batch rendering is the method most commonly used for inedible products. In this method, moisture is separated from the raw material by evaporation. Heat for evaporation is provided by steam in a jacket around the cooker, reaching process temperatures of 116-138 C (241-280 F). The areas around the process equipment are often hot; insulating process equipment and steam and condensate piping will result in a cooler environment. The water removed from the raw material in the cooking or evaporation step must be condensed and discharged into a sewer according to guidelines of local sewer ordinances for a city sewer or the Clean Water Act Amendments of 1977 for a navigable stream [5]. Vapor is condensed primarily by contact or by surface condensers located just outside the plant or on the roof. Noncondensable vapor from the condenser, which gives off highly intense odors, can be controlled by venting to a scrubber or directly to the boiler that generates the plant's steam.

After the moisture is removed, the liquid fat must be separated from the protein solids. In batch cooking, the initial separation is accomplished with a rectangular percolation pan that contains a perforated screen 6-inches above a sloped bottom. This configuration allows the fluid tallow to drain and be separated from the protein solids. The protein solids still containing about 25% tallow are conveyed to the screw press, which completes the separation. Solid protein material discharged from the screw press is known as cracklings. The cracklings are normally screened and ground with a hammer mill to produce meat-and-bone meal. These products are usually stored outside the plant in silos. Workers occasionally enter these silos for maintenance and repair work.

The liquid fat from the percolation pan and screw press can be processed by screening, settling, centrifuging, or filtering to remove fine solids. Liquid tallow or grease that remains may then be clarified or bleached with various clays or diatomaceous earth. The grease and tallow are usually stored in steam-heated tanks and held for shipping. Workers occasionally enter these tanks when empty to perform maintenance or repair work.

Each rendering plant has a facility for loading trucks, railroad cars, or barges to move the rendered materials to the user. Solids can be top-loaded or end-loaded with flingers (conveyors that throw material horizontally) into covered trailers or boxcars. Stored grease and tallow are liquefied and then pumped into tank trailers or rail tankcars.

(b) Continuous Cooker Processing

Continuous cooking systems for inedible rendering are increasingly common [1]. The receiving, grinding, pressing, and storing operations are similar to those discussed for batch cooking. Continuous systems evaporate water and separate fats by steadily moving the material through the cookers. Advantages of the continuous system over the batch process include improved quality control of the product, better confinement of odor and fat-particle aerosols within the equipment, and a smaller space requirement. Although use of batch cookers has steadily decreased, they may never be entirely replaced by continuous systems; small rendering plants often cannot afford continuous systems. Continuous systems are highly automated and can be operated with fewer workers, but also require a greater maintenance effort because failure of any part can shut down an entire system. The instrumentation and controls for a continuous system are usually centralized at a panel that may be enclosed in a booth.

Currently, the two most widely used continuous systems in inedible rendering are the Anderson C-G (Carver-Greenfield) system and the Duke system, shown in Figures I-3 and I-4, respectively [4]. The Anderson C-G system first uses a fluidizing tank in which recycled fat is used to heat and slurry the raw material. Then the slurry is pumped to a disintegrator for further grinding and for breakdown of cellular structure to release fats. The resulting charge is then pumped to the evaporator, where moisture is removed under vacuum. In the Duke system, the cooker resembles a batch cooker, but differs in that material is continuously charged at one end, driven slowly through the horizontal cooker, and steadily discharged at the other end. Other systems, in limited use, are the Strataflow, the Pfaudler Low Temperature Centrifuge, and the Norwegian Stord-Bartz Rotadisc.

Rendering operations that process a large volume of material are mechanically aided by screw conveyors, pumps, front-end loaders, and other equipment [4]. Pressure vessels and systems, such as feather hydrolyzers, cooker steam jackets, filter presses, and condensate returns, are also used. Other operations use boilers to generate steam or hot water and usually have some sort of system to recover the water vapor produced in the cooking process. For odor control, scrubbers or incinerators are used for cookers, dryers, and other process equipment.

Edible Rendering

Edible rendering usually takes place as an adjunct to slaughtering and dressing processes, where edible raw material is readily available. It has been estimated that less than 2% of independent processers render edible material [6].

A typical edible rendering process consists of a multistage centrifuge system that mechanically separates water from fat, in contrast to a cooking process in inedible rendering. In the edible processes, production volume and temperatures are usually much lower and sanitation requirements more stringent than in the inedible processes.

Batch processes, which are becoming obsolete, are either "wet-batch" or "dry-batch" [1]. In dry-batch low-temperature rendering, the charge is

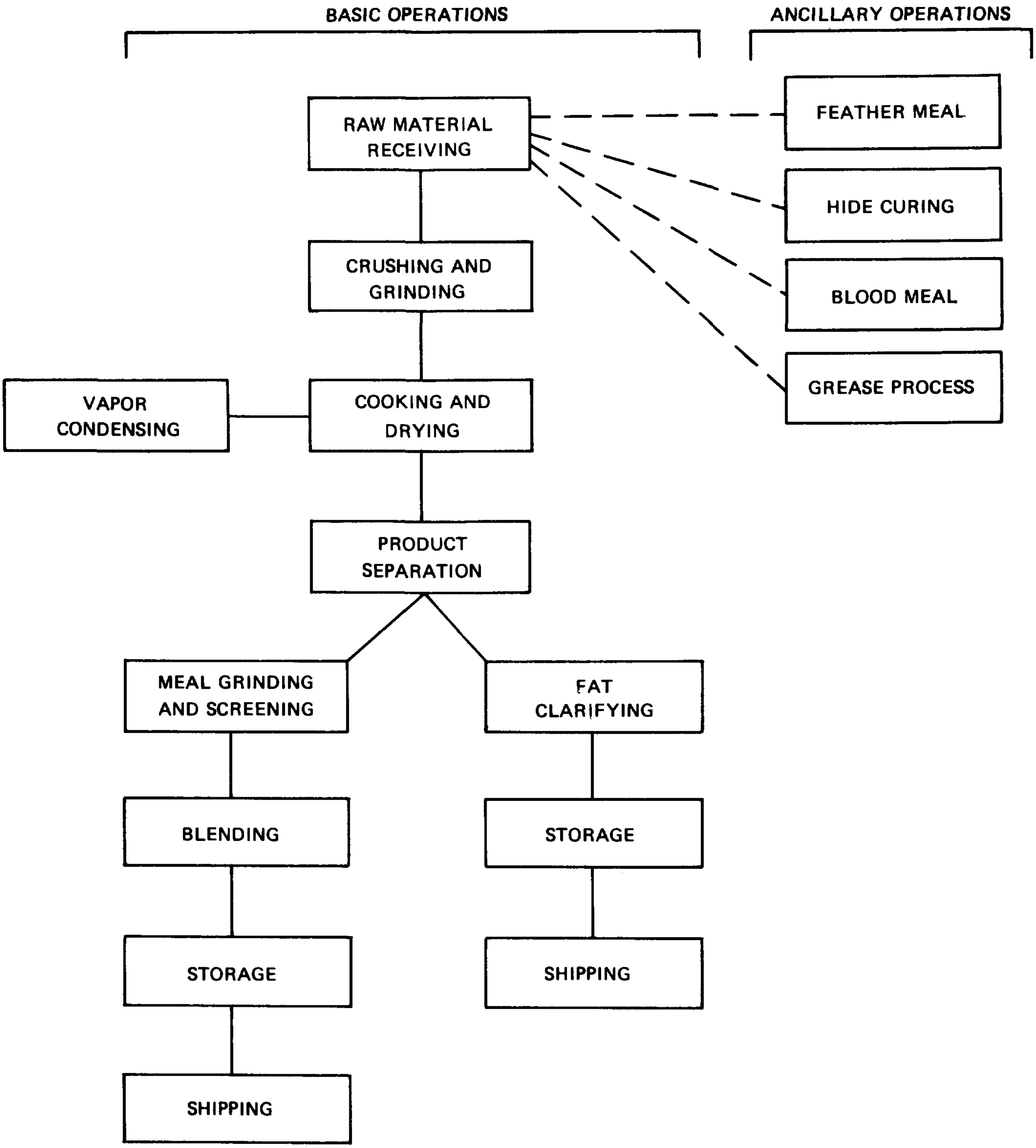

FIGURE I-1. FLOW SCHEME FOR BASIC RENDERING OPERATIONS

Adapted from reference 4

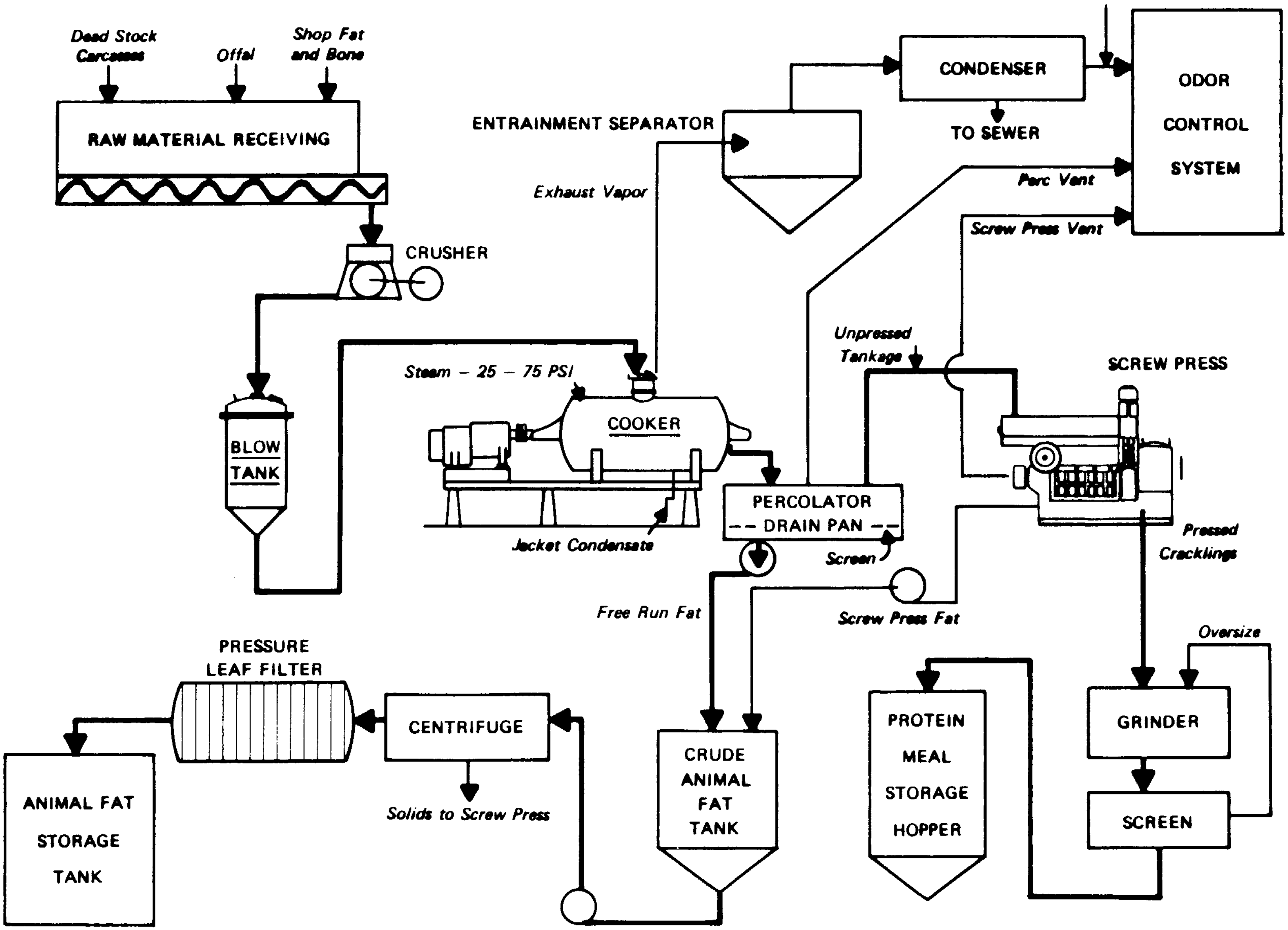

FIGURE I-2. A BATCH COOKER RENDERING SYSTEM

Adapted from reference 4

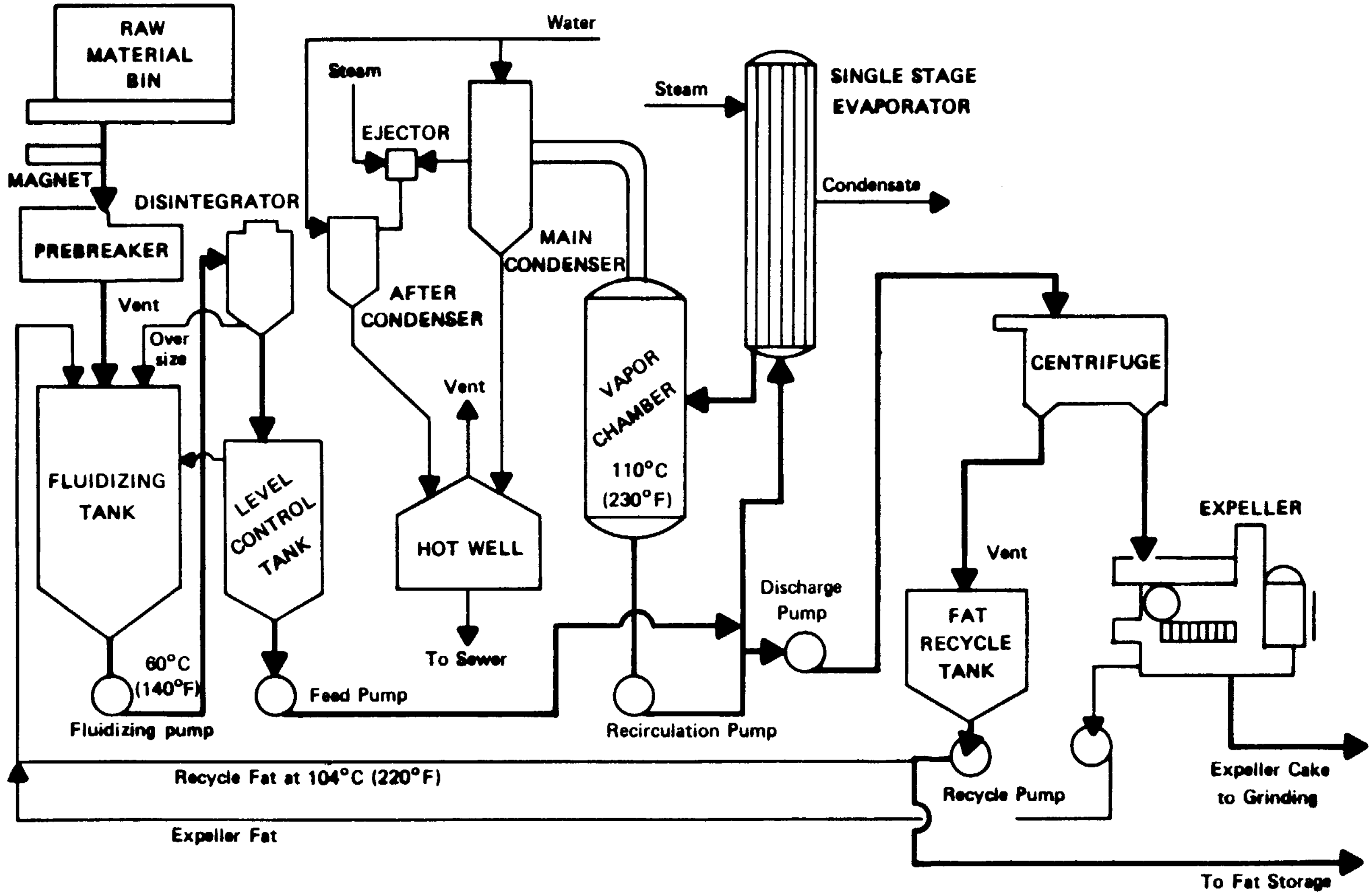

FIGURE I-3. THE ANDERSON C-G (CARVER-GREENFIELD) CONTINUOUS RENDERING SYSTEM

Adapted from reference 4

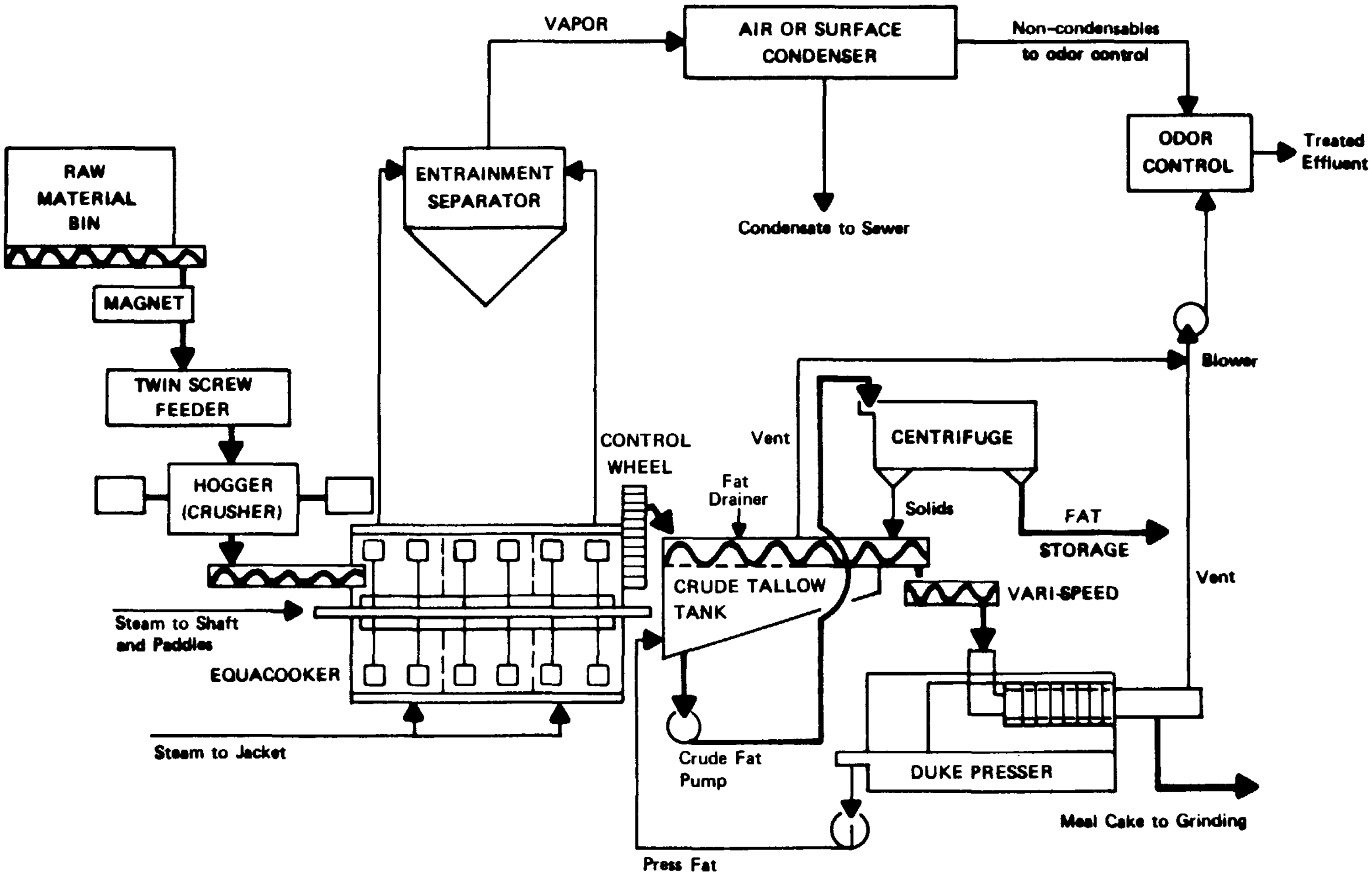

FIGURE I-4. THE DUKE CONTINUOUS RENDERING SYSTEM

Adapted from reference 4

melted in a conventional cooker at a temperature that does not evaporate the moisture in the raw material. The fats are separated from the solids and water by screening or centrifuging. Remaining water entrained in the hot fat is then removed in a second centrifuge. The separated water, called tank water, can be further evaporated to a thick material known as stick, which can be used as tankage for inedible rendering. The solids can be sent to inedible rendering or used in edible meat meals. In wet-batch rendering, now essentially outdated, the material is heated by direct injection of steam. Three materials result: water, fat, and suspended solids (protein tissue). The fat is decanted and the water and solids are separated by filtration or centrifugation.

Currently, edible material is most commonly rendered in continuous, wet systems in which low temperature and centrifugation are used to separate fats from water and solids (protein tissue) [1]. Raw materials are cut finely and heated, which fluidizes them. The fluid mass passes into a centrifuge to separate the fat (and water) from the solids. The resulting solids can be used as food fillers or as pet food. The fat and water mixture goes to a second centrifuge for further separation. The final fat is low in acid and faintly colored. Water goes to the water treatment system, and sludge goes to inedible rendering. Process temperatures are about 49 C (120 F) for edible lard and 68 C (155 F) for edible tallow.

Ancillary Operations

Ancillary operations performed in some rendering plants include the producing of blood meal and feather meal, the reclaiming of grease, the boning of dead stock for pet food, and the processing of hides.

Blood from the kill floor is coagulated and centrifuged, dried, and sold as a protein source for use in animal feed. Figure I-5 is a flow scheme for the process. Blood received from the sticking area of a slaughtering plant is preheated and coagulated by steam injection in the continuous process. Solids are separated from liquids by centrifuge, and then dried and ground. In continuous systems, a gas-fired direct-heat dryer (ring dryer) or a rotary steam tube can be used to dry the blood. In batch processes, coagulation and moisture removal are performed in the batch cooker by drying. Blood meal is valued as animal feed because of its high lysine content. A batch process is less desirable than a continuous one because it results in a lower lysine content of the blood meal.

Poultry feathers and hog hair are also processed in many plants (Figure I-6) [4]. The hair and feathers are hydrolyzed by cooking under pressure, dried in a steam tube or a ring dryer commonly at temperatures of 100 C (212 F), and then blended for use in animal feeds; feather or hair material may also be ground. Feather and hair meals are used as protein sources in animal feed.

The growth of the restaurant business has made the reclaiming of restaurant grease an important part of the rendering industry (F Ward, written communication, December 1978). This reclaimed grease is used as stabilized animal fat for animal feed. A brief outline of this process is shown in Figure I-7. Restaurant grease is delivered to rendering plants in large drums by bucket trucks or other types of barrel trucks. Drums weighing as much as 204 kg (450 lbs) are unloaded by hand or with mechanical aids, such as hand trucks or hoists. These drums are not only heavy, but many times have rough, sharp edges. The distance these drums are lifted, pushed, and pulled from the unloading dock to the hot room varies considerably from plant to plant. Steam, infrared radiation, or electric heaters are used to melt the grease while still in the barrels, which are drained through metal screens and cleaned. The grease is then filtered or screened to remove coarse solids, heated to remove water (water may also be removed by settling), and further filtered or centrifuged to remove the fine solids. The resulting yellow grease is blended with antioxidants and stabilizers, and stored or shipped out for animal feed as stabilized animal fat.

Some rendering plants supply pet food establishments with red meat. Good quality carcasses are placed on a rail where they are skinned and gutted. The meat is kept in a cooler and inspected until it is boned and sold the next day. At some rendering plants this accounts for about 10% of their total tonnage.

Many rendering plants that handle a large number of dead stock find it economically favorable to remove the hides from dead carcasses for curing. These carcasses are skinned while hanging from a rail or lying on the floor. The carcass is usually taken by conveyor or cable to the pre-breaker, and the hide is trimmed, cleaned, and then cured in brine raceway vats.

Chemicals Used During Rendering Plant Operations

Rendering plants use chemicals in several operations: cleaning, grease or fat processing, treating waste water, controlling odors, water cooling, and boiler operation [1,4]. A partial list of the more common chemicals is given in Table I-2.

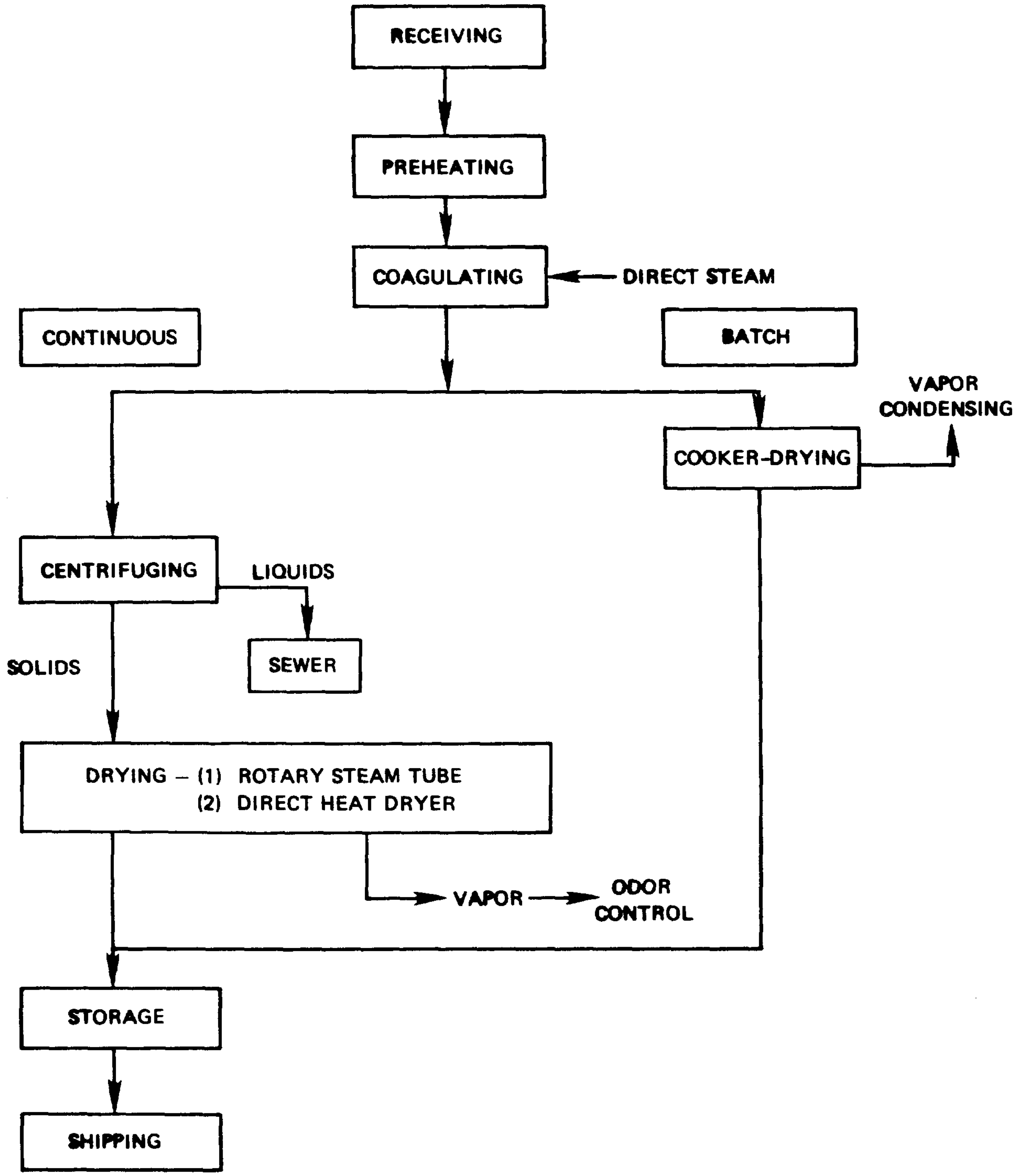

FIGURE I-5. FLOW SCHEME FOR A BLOOD MEAL OPERATION

Adapted from F Ward, written communication, December 1978

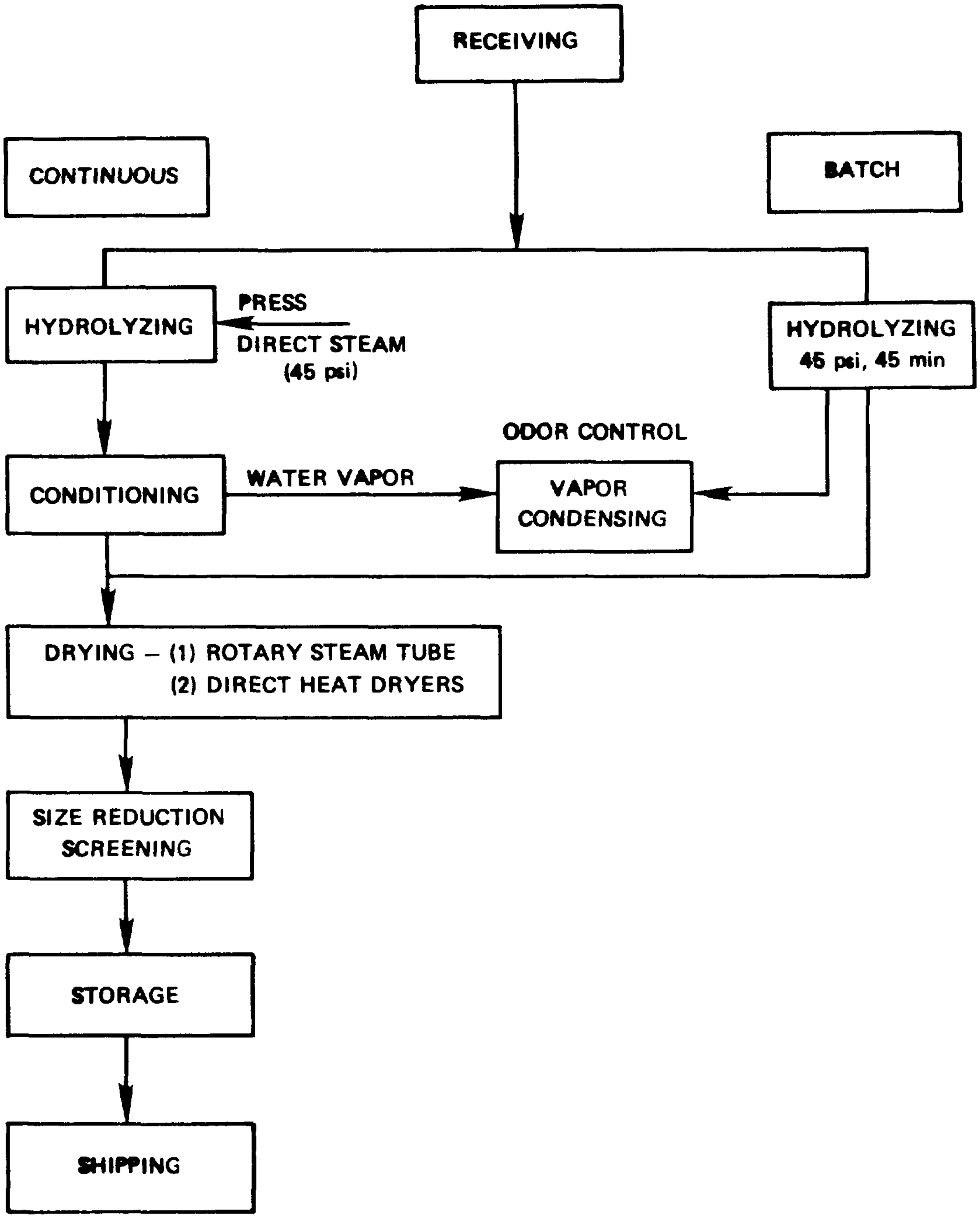

FIGURE I-6. FLOW SCHEME FOR A FEATHER MEAL OPERATION

Adapted from F Ward, written communication, December 1978

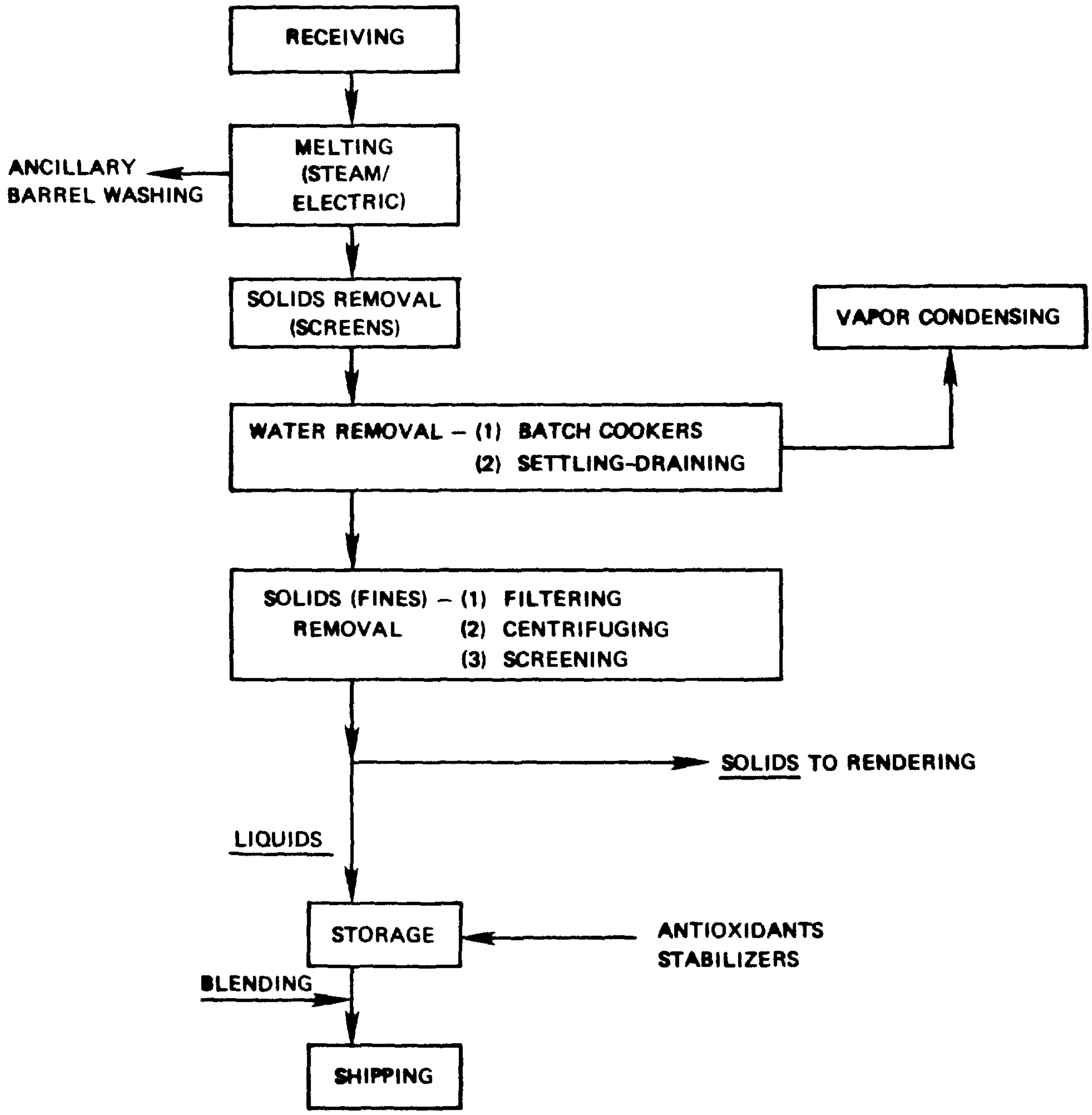

FIGURE I-7. FLOW SCHEME FOR A RESTAURANT GREASE OPERATION

Adapted from F Ward, written communication, December 1978

TABLE I-2

CHEMICALS, COMPOUNDS, OR AGENTS USED IN RENDERING PROCESSES

I. Cleaning, Sanitizing, and Disinfecting

- Sodium Carbonate
- Caustic Soda (Sodium Hydroxide*)
- Sodium Metasilicate
- Sodium Polyphosphates
- Sodium & Potassium Soaps

II. Processing System

- Antifoams - Silicones
- Sodium Sulfite
- Filter Aids - Diatomaceous Earths
- Bleaching Agents - Clays
- Trisodium Phosphate
- Salt (NaCl) and Lime (CaO)
- Stabilizing Agents - Antioxidants
    - Citric Acid
    - BHA and BHT - Phosphoric Acid
    - Propyl Gallate
    - Orthophosphoric Acid
    - MHA (Methionine Hydroxy Analog)
    - n-Propyl Alcohol
    - Silicate Mixtures

III. Waste-Water Treatment System

- Alum
- Ferric Chloride and Ferric Sulfate
- Lime
- Sulfuric Acid*
- Chlorine*
- Sodium Hydroxide*
- Polyelectrolytes - Anionic - Cationic
- Lignosulfonic Acid

IV. Odor Control System

- Sodium Hydroxide* and Sodium Hypochlorite
- Chlorine*
- Sodium Carbonate
- Sulfuric* and Sulfamic Acid
- Potassium Permanganate

V. Water-Cooling System

- Algacides, Chlorine*, Biocides, and Chlorinated Phenols
- Sulfuric Acid*
- Polyphosphates
- Low Molecular Weight Polymers - Polyacrylates
- Chromates* and Silicates
- Zinc Salts
- Sodium Nitrite
- Quaternary Ammonium Compounds

VI. Boiler System

- Salt (NaCl)
- Acid Cleaners
- Sodium Hydroxide*
- Sodium Carbonate, Phosphates, and Aluminate
- Chelants (EDTA, NTA)
- Polymers, Polyacrylates
- Tannins
- Sodium Sulfite and Nitrate
- Hydrazine**
- Filming and Neutralizing Amines
- Antifoams - Polyglycols, Silicones, Polyamides

VII. Hide Processing

- Sodium Hypochlorite
- Pentachlorophenol
- Curing Salt

*See NIOSH's criteria document on this compound for recommended standards and control procedures.
**Not very common

Adapted from F Ward, written communication, December 1978

II. OCCUPATIONAL HAZARDS

Occupational hazards in rendering plants can be divided into three categories: those resulting in mechanical injury, those resulting from physical agents, and those resulting from exposure to, or contact with, biologic and chemical agents.

Hazards Resulting in Mechanical Injury

According to the Bureau of Labor Statistics, the injury and illness incidence rate for the Animal and Marine Fats and Oils Industry (SIC code 2077) in 1977 was 25.0 cases/100 full-time workers (see Table II-1) [7]. Injury and illness rates in these establishments averaged approximately 1.9 times as much and lost workday cases about 2.7 times as much than their respective rates for the manufacturing industries sector between 1972 and 1977.

Although the number of lost-workday cases per 100 full-time workers was higher in animal and marine fats and oils establishments than comparable rates for the manufacturing industries sector, the average number of lost workdays per lost-workday case in these same establishments was lower. Table II-2 shows injury and illness rates for workers in animal and marine fats and oils establishments for 1972-1977. In each of these years, injuries accounted for approximately 96-98% of all reported cases.

The BLS has also recently developed the Supplemental Data System, which has as its source of data the first report of injury or illness submitted by employers and insurance carriers to worker compensation agencies of various states [12]. The source, type of accident, and nature of injury are described for compensable cases in 1977 for animal and marine fats and oils establishments in five states (Tables II-3, II-4, and II-5) [13]. (States with 50 or more total cases a year were selected to establish more reliably the leading causes of injury.) Cross-tabulation of source of injury and accident type, nature of injury with part of body affected, nature and source of injury, and nature of injury and accident type has been provided by these states [14]. These tables allow a more detailed analysis of the accident circumstances. Since the definition of a compensable case differs slightly from state to state, only general conclusions can be made concerning the sources, types of accidents, and natures of injuries in this industry. However, the summary data can help identify the areas in which engineering controls and safety activities need to be intensified and help pinpoint problems that must be solved.

(a) Walking-Working Surfaces

In rendering plants, walking-working surfaces were listed as the source of about 14% of the compensable injuries in the five states (Table

TABLE II-1

OCCUPATIONAL INJURY AND ILLNESS INCIDENCE RATES PER 100 FULL-TIME WORKERS FOR SELECTED INDUSTRIES, 1972-77

Industry	SIC Code**	Total Cases***	Lost Workday Cases	Nonfatal Cases Without Lost Workdays	Lost Workdays per Lost Workday Case
Manufacturing					
1972		15.6	4.2	11.4	14.9
1973		15.3	4.5	10.8	15.2
1974		14.6	4.7	9.9	15.5
1975		13.0	4.5	8.5	16.8
1976		13.2	4.8	8.3	16.6
1977		13.1	5.1	8.0	16.1
Fats and Oils	207				
1975		19.2	7.9	11.2	19.2
1976		20.9	8.0	12.8	16.7
1977		21.9	9.1	12.8	15.4
Animal and Marine Fats and Oils					
1972	2094	27.2	12.1	15.1	15.0
1973	2094	29.8	12.7	17.1	13.7
1974	2094	28.8	13.5	15.3	14.0
1975	2077	23.8	11.2	12.3	17.4
1976	2077	27.1	13.2	13.8	13.8
1977	2077	25.0	11.7	13.3	14.2

*Incidence rates represent the number of injuries and illnesses or lost workdays per 100 full-time workers and were calculated as (N/EH) x 200,000 where:
N = number of injuries and illnesses or lost workdays
EH = total hours worked by all workers during the calendar year
200,000 = base for 100 full-time-equivalent workers (working 40 hours per week, 50 weeks per year)

**The Standard Industrial Classification Manual--1967 edition was used to categorize the 1972-1974 data; 1972 edition was used for the 1975-1977 data. SIC 2077 became the four digit classification for animal and marine fats and oils.

***Because of rounding and fatality cases there may be a difference between the total and the sum of the rates for lost workday cases and nonfatal cases without lost workdays.

Adapted from references 7-11

II-3), with falls being the most common type of accident resulting from this source (Table II-4). The major factor in this type of accident is the amount of friction between the shoe sole and the working surface. Shoe/working surface friction is affected by floor conditions, floor surface material, and shoe sole composition.

TABLE II-2

OCCUPATIONAL INJURY AND ILLNESS RATES IN ANIMAL AND MARINE FATS AND OILS ESTABLISHMENTS

		Incidence Rates per 100 Full-Time Workers					
		Injuries			Illnesses		
Year	Average Number of Workers (x 1,000)	Total cases**	Lost Work-day Cases	Nonfatal Cases Without Lost Workdays	Total Cases**	Lost Work-day Cases	Nonfatal Cases Without Lost Workdays
1972	NA*	26.3	11.8	14.5	0.9	0.3	0.6
1973	"	29.0	12.4	16.6	0.8	0.3	0.5
1974	"	28.3	13.3	14.9	0.5	0.2	0.3
1975	"	23.3	11.0	12.1	0.5	0.2	0.3
1976	11.2	26.2	12.7	13.5	0.9	0.5	0.3
1977	NA	24.1	11.4	12.7	0.9	0.3	0.6

*NA = Not available

**Because of rounding and fatality cases there may be a difference between the total and the sum of the rates for lost workday cases and nonfatal cases without lost workdays.

Adapted from references 7-11

Grease buildup is the major contributor to unsafe walking and working surfaces. The extent of the hazard depends upon the specific rendering process being employed and the extent to which fat and grease particles are confined within the equipment. While continuous rendering systems are able to confine the fat and grease particles, batch cooker operations are not, especially when the animal material is dumped from the cooker to the perc pan. In this situation exhaust ventilation is needed to pick up and remove the airborne fat particles and water vapor before they settle. NIOSH observed that in plants with grease buildup, the second level floor surface where the fat and grease particles settled was more slippery than the first level floor surface [15].

Injuries from falls were usually sprains and strains, but there were also contusions, fractures, and lacerations (Table II-5) [13,14].

A review of the 1979 First Reports of injury or illness from the five selected states indicated that many slips and falls occurred when workers unloaded grease barrels or dead stock from trucks [16]. Spillage from these barrels during their movement to the hot room caused the smooth metal surfaces of the trucks and the loading dock to become slippery. Secure lids for these barrels would minimize the grease buildup from the spillage. Sometimes grease was dumped onto the floor of the hot room before it was melted; when this occurred the boots of workers spread the grease and, therefore, the hazard to other areas.

The hide processing area was also identified by these reports as another location in rendering plants where there is an increased risk of slips and falls. Workers there lift hides and heavy bags of salt for the curing process.

Good housekeeping will also help minimize the hazards presented by spilled or settled materials that characterize the work environment in some rendering plants. Employer adherence to the general regulations for walking and working surfaces, listed in 29 CFR 1910.22, will reduce hazards by providing for clean, dry, orderly, and sanitary surfaces in addition to sufficiently safe clearances in aisleways where mechanical equipment is used. These aisleways should be kept clear and dry.

Spillage can be minimized by ensuring that scrap carts, conveyors, and containers are not overloaded. Leaking pumps, pipes, and valves should be repaired promptly. When spills occur, the bulk of the fat and other solids may be removed with a shovel, and then the floor should be cleaned with water. As an alternative, absorbents can be used to absorb the grease and fat, and then swept up and discarded. Cleansers should be used to remove any remaining fat and grease. Subsequently, any remaining water or liquid should be mopped up and the surface dried as completely as possible.

The type of floor surface can contribute to unsafe walking and working conditions. Independent rendering plants visited by NIOSH usually used smooth metal floors at the grease barrel unloading dock. While these floors provide the strength to resist damage from 204-kg (450-lb) barrels, they offer little slip resistance [15].

Much use is made of metal plates, of either solid, expanded, or serrated metal, as flooring, stairs, loading dock areas, walkways, and catwalks. The walking-working surface of the solid plate can be finished in a raised pattern to increase its slip-resistance. However, at one rendering plant where an abrasive material was incorporated onto the steel floor to provide more traction, the grease barrels destroyed the finish after only a few days. If the slip-resistant surfaces are vulnerable to barrel abuse, then conveyors or other automatic barrel movers should be considered. At another plant, the plant manager was thinking of installing tracks so he could roll the barrels from the trucks to the hot room, thus avoiding damage to the floor surface [15].

One type of solid rolled steel flooring has impregnated aluminum oxide particles. As the surface wears down, particles of the aluminum oxide are continually exposed to the walking-working surface. This type of plate material may be used as a structural component or laid down over existing flooring of all types [17].

Concrete surfaces, especially those with broom finishes, provide traction in other areas of the plant until they are worn smooth. Concrete floors have marginal wear resistance. Brick floor surfaces present a reasonably slip-resistant surface. Floor brick with a cast-abrasive surface is even better [18].

BLS data and the First Reports suggest that stairs in some rendering plants are particularly hazardous, involving 14 of the 55 working surface cases reported by four of the five states. At the independent rendering plants visited by NIOSH, the stairs always seemed hazardous to climb because they were slippery. At one plant, however, the stairs were made of corrugated metal that provided better traction [15].

The type of footwear worn by workers can contribute to slips and falls. Shoe-working surface friction is affected by the shoe sole and heel composition and contact area [17]. Most neoprene sole and heel materials provide a high degree of slip resistance and are resistant to leaking. Since most areas of (independent) rendering plants present some hazard of slips and falls, workers should be required to wear rubber or neoprene boots, preferably with safety toes. The material from which boot soles are constructed is more important than the sole pattern. A highly slip-resistant material with very little pattern is the safest type of footwear, as it provides greater contact with the floor surface [18].

Adherence to regulations for covers and guardrails will protect workers from the various hazards associated with open pits, tanks, bins, and vats (29 CFR 1910.23). In independent rendering plants, the raw-materials receiving pit is often more than 4 feet (1.2 m) deep and is routinely equipped with conveyors or augers at the bottom to move the material into the grinding system. Raw material is dumped into the pits from dump trucks, flatbed trucks, barrels, and wheelbarrows. Standard guarding is necessary protection at these openings; however, special modifications of a toeboard on the charging side of the opening may be appropriate so it will not interfere with cleanup of raw materials spilled during the charging operation.

TABLE II-3

SOURCE OF INJURY OR ILLNESS (SIC CODE 2077)

Number of Cases Within a State
Percent of Cases Within a State

State:Year	Boxes, Barrels, Containers	Chemi-cals	Hand Tools	Machines	Metal Items	Vehicles	Wood Items	Working Surfaces	All Other classi-fiable	Non-classi-fiable	Total
California: 1977	28	2	8	2	12	16	-	17	42	3	130
	21.5	1.5	6.2	1.5	9.2	12.3	-	13.1	32.3	2.3	100.0
Idaho: 1977	9	4	10	-	10	5	1	13	24	1	77
	11.7	5.2	13.0	-	13.0	6.5	1.3	16.9	31.2	1.3	100.0
Missouri: 1977	12	4	6	1	22	12	1	17	27	12	114
	10.5	3.5	5.3	0.9	19.3	10.5	0.9	14.9	23.7	10.5	100.0
Nebraska: 1977	7	1	16	-	1	2	1	8	24	1	61
	11.5	1.6	26.2	-	1.6	3.3	1.6	13.1	39.3	1.6	100.0
Wisconsin: 1977	5	3	18	2	7	6	3	14	34	4	96
	5.2	3.1	18.8	2.1	7.3	6.3	3.1	14.6	35.4	4.2	100.0
Percent weighted average by source*	12.8	2.9	12.1	1.0	10.9	8.6	1.3	14.4	31.6	4.4	100.0

*The sum of cases from a specific source (column) for the five reported states divided by the sum of cases from all sources for the five reported states, expressed as percentage

Adapted from reference 13

TABLE II-4

TYPE OF ACCIDENT OR EXPOSURE (SIC CODE 2077)

Number of Cases Within a State
Percent of Cases Within a State

State:Year	Struck By or Struck Against	Fall	Caught In or Between	Rubbed or Abraded	Over-Exertion	Contact With Extreme Temperatures	Contact with Radiation, Caustics, etc	Motor Vehicle Accident	All Other Classifiable	Non-classifiable	Total
California: 1977	29	21	11	6	34	13	4	4	7	1	130
	22.3	16.2	8.5	4.6	26.2	10.0	3.1	3.1	5.4	.8	100.0
Idaho: 1977	40	9	6	-	10	4	4	2	2	-	77
	51.9	11.7	7.8	-	13.0	5.2	5.2	2.6	2.6	-	100.0
Missouri: 1977	46	21	6	3	6	8	5	5	6	8	114
	40.4	18.4	5.3	2.6	5.3	7.0	4.4	4.4	5.3	7.0	100.0
Nebraska: 1977	18	9	1	6	12	2	5	1	7	-	61
	20.5	14.8	1.6	9.8	19.4	3.3	8.2	1.6	11.5	-	100.0
Wisconsin: 1977	36	15	3	4	16	2	12	2	4	2	96
	37.5	15.6	3.1	4.2	16.7	2.1	12.5	2.1	4.2	2.1	100.0
Percent weighted average by type of accident*	35.4	15.7	5.6	4.0	16.3	6.1	6.3	2.9	5.4	2.3	100.0

*The sum of cases from a specific source (column) for the five reported states divided by the sum of cases from all sources for the five reported states, expressed as percentage

Adapted from reference 13

TABLE II-5

NATURE OF INJURY OR ILLNESS (SIC CODE 2077)

Number of Cases Within a State / Percent of Cases Within a State

State:Year	Amputations	Burns	Contusions, Bruises	Cuts, Lacerations	Fractures	Scratches, Abrasions	Sprains, Strains	Occupational diseases	All Other Classifiable	All Non-classifiable	Total
California: 1977	-	15	10	22	10	4	51	2	1	15	130
	-	11.5	7.7	16.9	7.7	3.1	39.2	1.5	.8	11.5	100.0
Idaho: 1977	-	7	16	19	4	10	17	-	4	-	77
	-	9.1	20.8	24.7	5.2	13.0	22.1	-	5.2	-	100.0
Missouri: 1977	-	8	17	20	7	1	24	4	25	8	114
	-	7.0	14.9	17.5	6.1	0.9	21.1	3.5	21.9	7.0	100.0
Nebraska: 1977	-	4	1	16	7	-	23	3	7	-	61
	-	6.6	1.6	26.2	11.5	-	37.7	4.9	11.5	-	100.0
Wisconsin: 1977	-	3	10	23	7	3	23	16	6	5	96
	-	3.1	10.4	24.0	7.3	3.1	24.0	16.7	6.3	5.2	100.0
Percent weighted average by nature of injury*	0	7.7	11.3	20.9	7.3	3.8	28.9	5.2	9.0	5.9	100.0

*The sum of cases from a specific source (column) for the five reported states divided by the sum of cases from all sources for the five reported states, expressed as percentage

Adapted from reference 13

(b) Boxes, Barrels, Containers, and Dead Stock

In the five selected states, about 13% of the injuries listed were attributed to work with boxes, barrels, and other containers. Another 4% could be attributed to animal products such as carcasses, bones, and hides. Approximately 16% of all accidents were listed as overexertion (Table II-4), which most frequently involves lifting, pulling, or throwing of objects. The most common injury involved sprains and strains, frequently to the back [14].

Rendering plants that process restaurant grease will handle many heavy barrels, and plants that process hides and pet food will handle more dead stock than other plants. Many plants do not handle any dead stock, but plants in the west and midwest process more dead stock than those in other parts of the country. In plants that process hides, lifting, pulling, and throwing injuries involving hides and heavy bags of salt are problems.

A work practice guide for manual lifting has been developed by NIOSH [19]. This guide makes recommendations for controlling various hazards related to unaided symmetric (two-handed) lifting of an object of known weight and size. Quantitative recommendations regarding the safe load weight, size, location, and frequency of handling are presented. In addition to recommendations for the selection and training of workers who must manually handle materials, the guide presents some engineering and administrative controls. The guide will help employers determine which lifting tasks being performed in their plants are unacceptable without engineering controls (above a maximum permissible limit (MPL)); unacceptable without administrative or engineering controls (between the action level (AL) and the MPL) and which are acceptable (below the action level). More detailed information on the maximum permissible limits and action levels can be found in the NIOSH work practice guide for manual lifting [19].

Employers should ensure that hazardous pushing, pulling, and lifting tasks not covered by the NIOSH guide are either performed with the aid of some mechanical device, such as a hoist, or redesigned so that they can be performed safely. While a hoist will reduce the physical hazards associated with manual pushing, pulling, and lifting, it could introduce new physical hazards unless operational guidelines are developed and followed. In some rendering plants, workers clean up under perc pans held up by hoists. Inspection of hoists and their ceiling connections for possible corrosion should be performed frequently. Employers should also consider the use of jacks or posts as safety supports for perc pans.

At one rendering plant visited by NIOSH, workers responsible for unloading grease barrels were aided by a conveyor that moved the grease barrels from the unloading dock to the hot room. After the grease was melted the barrels were automatically turned upside down and emptied. This greatly reduced the manual pushing, pulling, and lifting performed at this plant [15].

NIOSH visited two other rendering plants that handled barrels of restaurant grease. At one of these, workers used hand trucks to move the barrels; at the other plant, because the hoist was inoperative, the workers moved the barrels manually. Minimizing the distance required to move the barrels will also reduce the amount of pushing, pulling, and lifting [15].

Any worker involved in lifting, pushing, or pulling should be required to wear safety-toe footwear. Since these jobs are usually performed on slippery surfaces, the safety footwear should have soles made of slip-resistant material. Safety-toe footwear of the proper type is effective in reducing material handling injuries as well as slips and falls. Recommendations for safety-toe footwear are presented in ANSI Z41.1-1967.

The lids of barrels and other containers are often rough, and cuts and lacerations may result from handling them if gloves are not worn. Workers should be required to wear gloves when handling barrels and other containers.

(c) Hand Tools

Hand tools were listed as the source of about 12% of the compensable injuries in rendering plants in the five states (Table II-3). Renderers use knives and axes, as well as maintenance tools such as wrenches, hammers, and small hand-held power tools including drills, welding torches, and small saws. Cuts and lacerations, most frequently of the fingers and hands, are caused often by hand tools.

The most frequent hand tool accidents in many rendering plants involve knives. In some rendering plants knives are used to skin, gut, and bone carcasses and trim hides. Skinners of dead stock have often injured fingers, hands, arms, thighs, knees, legs, and feet [16]. According to the 1979 First Reports, hide trimmers had similar accidents. These rendering plants should have a knife safety program that includes the use of personal protective equipment and training. The First Reports cited above indicate that when a worker was cutting a carcass every part of his body was vulnerable to knife wounds. The use of personal protective equipment should, therefore, be as extensive as possible.

Other frequent causes of hand tool injuries result from cleavers, axes, and large knives used to reduce the animal carcasses to a size that is amenable to the rendering plant's equipment. Protective equipment including mesh gloves, arm protectors, and abdominal protectors should be used by workers cutting up the carcasses. Knives used in this task should have maximally guarded handles, designed to prevent the hand from slipping onto the blade.

Hand tool-related injuries during maintenance operations can be reduced by the use of personal protective equipment such as safety shoes and gloves and by training workers in the proper use of tools. General industry standards for the use of hand tools are listed in 29 CFR 1910.241-1910.247. Hand saws and other powered tools must be properly grounded, insulated, or enclosed because of the wet conditions that often exist during their use. Powered equipment that uses a constant pressure switch must be chosen, when available, in order to shut off the power when the operator releases the pressure. To protect the eyes from flying particles when grinding, cutting, or sawing, workers should wear appropriate eye protection, such as face shields, safety glasses with side shields, goggles, or a combination.

(d) Powered Industrial Trucks

Vehicles were reported to be involved in about 9% of the injuries (Table II-3). All vehicles used in the industry were included, such as raw material pickup trucks, forklift trucks, and front-end loaders. Vehicle-related accidents occur both in the collection of raw material from butcher shops, restaurants, and meatpacking plants (activities not included in the scope of this document), and in the rendering plants themselves.

Adherence to the regulations for powered industrial trucks listed in 29 CFR 1910.178 will reduce these injuries. They require safety training of operators, installation of mirrors at blind corners, inspection of vehicles prior to use, and the use of only properly maintained equipment.

(e) Metal Items

Metal items such as shafts, discs, and pulleys were involved in about 11% of all compensable injuries in the selected states (Table II-3); most injuries were cuts, lacerations, and contusions [14]. Metal-item-related injuries occurred primarily in the handling of these objects during maintenance in tight quarters and around hot equipment in an uncomfortable (hot and humid) environment. These injuries can be prevented by the use of protective equipment such as safety shoes, gloves, and head protection (hard hats) and the training of workers in proper materials handling techniques.

(f) Machines and Conveyors

Machines such as grinders, cookers, presses, and centrifuges were the source of about 1% of the compensable injuries (Table II-3). These machines are a relatively minor source of compensable injuries in the rendering process. Adherence to the general regulations for machine guarding listed in 29 CFR 1910 Subpart O will continue to protect the operator and other workers from the moving parts of machines.

Rendering plants use screw conveyors (augers) to move material through the process. To prevent workers from coming into contact with moving parts, conveyors should be provided with covers that are either bolted on or electrically interlocked, which ensures that the conveyor will not be operated without proper guards in place. Where screw conveyors cannot be fully enclosed (receiving points and some points of discharge), they should be hooded or guarded by location or other suitable barrier. Start and stop controls should be located and guarded to prevent accidental operation, and a sufficient number of controls should be provided throughout the process area to stop the conveyors in an emergency.

Plant machines and conveyors require maintenance, inspection, cleaning, adjusting, and servicing. Work that requires entrance into, or close contact with, machines or conveyors should not begin until lockout/tagout procedures are followed. NIOSH is preparing a document on controlling maintenance hazards that result from the presence of energy [20]. The recommendations of this document are applicable to industries that use hazardous levels of energy for machines or processes and where maintenance activities could bring workers close to resulting hazards. In these instances, maintenance should only be performed after the energy is eliminated or controlled in accordance with the recommendations.

The employer should be aware of the Federal regulations (29 CFR 1910.179) for the operation of cranes used to repair rendering equipment. Regulations also exist (29 CFR 1910.184) for the selection and inspection of chains used for hoisting. Workers should never attempt to unkink a chain that is under stress.

(g) Hot Objects

Steam and hot water, fat products, and process equipment such as cookers and ring dryers are sources of burns in rendering plants. Burns were reported in about 8% of the compensable cases (Table II-5).

Steam and hot water are frequently used in some rendering plants to hose down equipment and greasy, slippery areas. In some First Reports, workers burned their legs and feet while using steam or hot water to clean their boots [16]. Some workers using cold water-steam mix hoses for hot water operations have been exposed to steam when they mix too much steam with water. Other workers have been burned by steam and hot water because they lost control of hoses during cleanup operations.

Steam and hot water lines should be marked and insulated. Hose used for cold water-steam mixes should be approved for use with steam. Cold water-steam mixes for obtaining hot water can be used only if suitable thermostatically-controlled mixing units are used. Mixing units need to withstand temperatures of 180 F (82 C) at a pressure of 150 psi. To discourage workers from using a hose with water temperatures ranging from 140 to 180 F (60 to 82 C) to wash personal equipment, equipment wash-off stations should be established in the plant. Water temperatures at these stations should be no higher than 120 F (49 C). To eliminate accidents occurring when workers lose control of a hose, steam and hot water hoses should be equipped with pressure-activated nozzles. These nozzles automatically shut off the steam or water when the worker lets go of the nozzle. To prevent hoses from rupturing, frequent inspections should be made to assess the condition of the hose. Mixing valves should also be inspected frequently.

(h) Repetitive Body Motion

When an injury is due to a worker's repetitive motion rather than to what he is doing with an object, bodily motion should be designated as the source of the injury. Research has shown that cumulative trauma disorders of the hand and wrist are a common problem for workers who perform repetitive manual work. In recent years, tendonitis and tenosynovitis have become significant occupational diseases in some industries. In rendering plants, some operations with knives and shovels are repetitive. In Nebraska, bodily motion was listed as the source of 8% of all rendering injuries. Sprains and strains are the most frequent type of injury resulting from bodily motion [14]. There are reports [16] of tenosynovitis in workers who skinned dead stock.

Hazards from Physical Agents

(a) Noise

Workers may be exposed to high noise levels in some rendering plants because boilers, pre-breakers, crushers, disintegrators, and grinding mills can generate noise exceeding 90 dBA (Table II-6).

In 1976, an OSHA inspection of an independent plant found that an operator at a control panel of the inedible rendering operation was exposed to a time-weighted average noise level of 91 dBA during an 8.5-hour exposure. The control panel in this plant was between two cookers, with a hogger (bone crusher) overhead.

Unsuccessful attempts to reduce the noise level included installing rubber pads under motor mounts, maintenance of bearings, installing a curtain to reduce the impact of ground bones on the side of the bin, and separating the metal parts of processing equipment with sound-deadening materials. The successful solution was to install a control booth. The booth is used by the operator to monitor the machinery control panel and to do paperwork. With the doors of the booth closed, readings of 72 to 75 dBA were obtained at times of highest noise generation. Noise levels in this plant are typical for a plant with similar equipment and equipment layout (D Mackenzie, written communication, January 1979).

During NIOSH visits [15] to two independent rendering plants with Duke rendering systems, noise measurements were made. The control panel in one plant was in front of two cookers and closely surrounded by the rest of the process equipment, except for the hammer mill which was in an adjacent room. Noise levels of 91 dBA and 96 dBA were recorded at the control panel and hammer mill, respectively. At the other plant where the hammer mill was completely isolated in a separate room, 81 dBA was measured at the control panel. A different layout of process equipment at this plant was also a factor in the lower noise measurements.

Noise measurements taken 6 feet (2 m) in front of hammer mills at four rendering plants visited by NIOSH ranged from 94 to 106 dBA. These levels contributed to background noise levels at work stations in the plant.

Information has been obtained concerning noise levels near process equipment (Anderson IBEC continuous system) at two rendering plants (A Phifer, written communication, June 1978). The data are presented in Table II-6. With the exception of one location, the reported area noise levels equaled or exceeded 90 dBA. In the boiler area, measurements of 97 and 98 dBA were recorded. The extent of worker exposure to noise at these levels was not recorded. Except for the boiler room, similar noise levels were obtained on a NIOSH plant site visit at another rendering plant with an Anderson system. Noise level measurements taken at cookers and expellers (presses) were usually greater than 85 dBA, but they always included background noise [15].

Engineering controls and preventive maintenance are important elements of noise control. Proper maintenance of bearings, drive gears, rollers, and other moving parts is important in minimizing noise generation. Some noisy equipment may be enclosed and insulated. At some rendering plants visited by NIOSH, the layout of the process equipment, including the complete isolation of the grinding mills in a separate room, provided a work environment without exposure to high noise levels. Mufflers may be used on steam or compressed-air exhausts. Soundproof booths or enclosed control rooms may also be provided for operators in a noisy environment. If noise levels or exposure periods cannot be reduced, warning signs should be posted in the exposure area, and workers in the area should wear hearing protection, such as ear muffs, rubber or foam earplugs, or fiber plugs. Various NIOSH publications contain information necessary for an effective noise control program [21-23]. Noise control should be considered when purchasing new equipment.

(b) Fire

Industry professionals have cited fire as a common danger in rendering plants. The fire hazard rating of rendering plants is high, according to Best's Loss Control Engineering Manual [24], which provides data on the insured loss (fire, workmen's compensation, product liability) of a broad cross-section of industry. Best's rating system is based on the average experience of insurance companies encompassing 90-98% of the premiums written. Batch rendering operations received a rating of 8 on a scale of 0 to 10, with 10 representing the greatest hazard of fires. Older batch plants are more susceptible because they were constructed with wood or other combustible materials. Continuous rendering operations were considered less hazardous, but no numerical ratings were given. Continuous systems are usually installed in new buildings constructed of steel and concrete block or other noncombustible materials (W Prokop, written communication, June 1978).

A leading cause of industrial fires is defective electrical equipment and wiring [25]. Specific problems at rendering plants include improperly grounded equipment, frayed and bared wires, wet material around electrical outlets, and loose and corroded conduit connections. Electrical equipment and wiring should be installed and maintained in accordance with the latest National Electrical Codes. Because of the corrosive nature of the chemicals used and given off in rendering plants, all electrical equipment and wiring should be periodically inspected and tested to detect deficiencies and ensure continued satisfactory performance. Automatic sprinkler or foaming systems can be used effectively for fires in rendering plants, but they must be properly located for maximum efficiency.

TABLE II-6

NOISE-LEVEL MEASUREMENTS AT TWO RENDERING PLANTS*

Location of Noise Measurement	Decibels("A" scale reading)	
	Plant A	Plant B
Pre-breaker	95	93
Disintegrators	96	92
Expellers	93	90
Centrifuge	-	93
Operating floor	94	93
Filter press	-	90
Grinding mill	92	89
Two boilers	97 (1 on)	98 (2 on)
Boiler header steam leak	104	-

*Area measurements; personal monitoring was not performed.

Adapted from A Phifer, written communication, June 1978

Welding and thermal cutting pose a potential fire hazard in confined spaces and rendering plant areas in which grease and other combustible materials have accumulated (A Phifer, written communication, June 1978) [16]. They should be performed under maximum fire-safe working conditions. Grease or other combustible deposits must be removed from the working surface, and sparks should be contained. Fire extinguishing equipment suitable to the plant area should be available in adequate quantities within easy reach (A Phifer, written communication, June 1978).

Excessive heat generated by friction is another major source of fires. Such excessive heat may result from inadequate lubrication, misaligned bearings, and improperly adjusted belt-driven machinery. A program of preventive maintenance that includes frequent inspections can minimize the risk of fires from these sources. Spontaneous ignition may also occur in rendering plants, particularly in the perc pans of the batch cooker systems if rendered material, heated to temperatures above 120 C (250 F), is held in the pan for a prolonged period (eg, overnight) [26]. Fires of this type reportedly can be avoided if the material is processed within 8 to 12 hours after the fat is drained (W Prokop, written communication, December 1979).

Fat mists from cookers may coat the entire inside of a rendering plant. Although fats do not have a low flashpoint, they can be ignited by open flames used carelessly or by uncontrolled heating. If exhaust ventilation is used to prevent the settling of released fat aerosols, the exhaust ductwork must also be kept clean. Exhaust fans should be equipped for automatic shutoff in the event of fire.

Proper operation and maintenance of boilers and other pressure vessels are essential to their safe use. Boilers must be operated in strict conformance with local codes. At a minimum, all pressure vessels should be equipped with rupture discs and vents to prevent explosion.

(c) Heat

Some rendering plant workers (especially those working above hot process equipment) are exposed to hot and humid work environments, particularly during the summer [15,24]. Such exposure may result in heat stroke, heat exhaustion, heat cramps, heat rash, and heat fatigue.

A worker's ability to do his job is affected by working in hot environments. Heat tends to promote accidents due to the slipperiness of sweaty palms, dizziness, or the fogging of safety glasses. Since the frequency of accidents in general appears to be higher in hot environments, it is important to ensure that thermal stress does not make rendering jobs more dangerous [27].

Much heat is created in rendering plants by equipment such as cookers and dryers. Energy conservation efforts that insulate hot equipment and steam and condensate piping will help reduce the heat load in rendering plants. Local exhaust systems at heat sources and general plant ventilation systems can also remove heat and humidity from the work areas (A Phifer, written communication, June 1978) and increase air circulation.

If heat stress is suspected, various means can be used to alleviate it. These means seek to reduce heat storage by the body, either by limiting input heat load, limiting metabolic heat load, or limiting exposure duration. In practice this can be radiant heat shielding, forced air movement, clothing designed to minimize heat absorption and maximize evaporative cooling, and worker rest schedules designed to prevent body temperatures from increasing over the work shift [28].

Intake air, cooled by water-heat exchange, was directed at job stations for workers operating cookers at one plant visited by NIOSH [15]. A NIOSH criteria document on hot environments [28] recommended that newly exposed workers be acclimatized and that exposure time be short. A joint OSHA/NIOSH pamphlet, Hot Environments, is available to give employers and workers an overview of the health hazards of work in hot environments and to alert them to the precautions needed to avoid excessive heat stress [27].

Hazards from Biologic and Chemical Agents

(a) Acute Toxicants, Including Asphyxiants

The anaerobic decomposition of biologic material can produce gases that may accumulate in drains, sewers, tanks, and other confined or enclosed spaces. Fatalities reported by two rendering facilities resulted from an apparent accumulation of toxic gases in confined spaces [29,30]. Since this has not been widely recognized as a hazard in the rendering industry, these episodes are discussed here in detail.

In 1975, workers died at a rendering plant where they were exposed to gases thought to be the result of decomposition of animal material [29,31]. Six men were asphyxiated when a clogged drain was opened, presumably releasing lethal quantities of gaseous products into a confined space.

The animal materials had been delivered by truck, weighed, and dumped into a large holding pit for materials to be rendered [29,31]. After the trucks were unloaded, they were washed out, the drainage entering another pit (for waste collection) below the scales. This pit normally drained into a third, adjoining pit by gravity through a 6-inch drain pipe. However, the drain pipe was thought to have been clogged for 2 to 7 days [29,31].

A maintenance man descended into the third pit to open the clogged drain, spending approximately 20 minutes in the pit with no apparent ill effects [31]. Later, he reentered the third pit to shut off a sump pump but collapsed while attempting to climb out. Five men attempting to rescue him also died after entering the pit. None wore respiratory protection of any kind.

Medical and autopsy findings showed signs of general hypoxia (stated as anoxia [29]) with acute edema of the brain and lungs. Four of the six victims had severe respiratory irritation, and one had a greenish discoloration of the viscera. Lung samples from five of the victims were analyzed by gas chromatograph for entrapped hydrogen sulfide; four lung samples from persons who had died from nonindustrial causes were analyzed as controls. Hydrogen sulfide was identified in all samples from the victims and in none from the controls. In addition, coins and keys in the pockets of some victims were darkened, and an analysis of them was positive for sulfur.

Sludge samples collected from the bottom of the pit were refrigerated on the night of the accident and tested qualitatively for hydrogen sulfide the next morning with lead acetate. The tests were positive [31]. On the day following the accident, lead acetate paper exposed 3 feet (0.9 m) above the sludge was positive for hydrogen sulfide. The toxicology department at Ohio State University collected a 40-liter air sample from the pit on the day after the accident, using a cadmium chloride solution in a midget impinger [31]. Approximately 15 ppm of hydrogen sulfide was found in the sample. Samples collected in Saran bags by NIOSH personnel 2 days after the accident showed traces of hydrogen sulfide (2-3 ppm), but were negative for methane, combustible gases, oxygen deficiency, and oxides of nitrogen.

The investigators interpreted the evidence as indicating that the deaths were probably caused by exposure to gases produced by decomposition of sulfur-containing organic material [29]. On the basis of the medical and environmental findings (symptomatology, pathologic findings, qualitative identification of gases in air and sludge) and of the operational circumstances and history of this episode, hydrogen sulfide alone or a combination of carbon dioxide, methane, and hydrogen sulfide was believed to be the most likely cause [29].

A similar episode was reported recently [30]. Two workers died in June 1980 at a rendering facility of a poultry processing plant where they were exposed to an oxygen-deficient environment or to gases that were thought to have resulted from decomposition of animal material. The two men were asphyxiated when they climbed to the bottom of a 15-foot (meat) overflow holding tank (#2) that possibly contained lethal quantities of gaseous products.

This overflow tank (#2) was filled with chicken parts (head, feet, and viscera) whenever the cooker and another overflow tank (#1) were full. The material placed in the overflow tanks was usually processed within 14 hours. Although the inside of overflow tank #1 was cleaned out at least three times per week, the inside of overflow tank #2, because of its location, was not cleaned out regularly. To give it a clean appearance, however, the outside was cleaned regularly.

The men were requested to enter the tank (#2) to remove roofing material that had fallen into the tank the day before. Both men collapsed and died while inside the tank, neither man wearing respiratory protection of any kind. No autopsies were performed. At high temperatures, the sulfur-containing amino acids in the poultry offal remaining in the overflow tank could have degraded and produced hydrogen sulfide. The roofing material clogged a drain at the bottom of the tank, allowing buildup of any gases that may have formed [30]. The evidence indicates that the deaths could have been caused by hydrogen sulfide exposure produced by decomposition of sulfur-containing organic material.

Details of the toxicologic effects of occupational exposure to hydrogen sulfide and carbon dioxide, and recommendations for workplace exposure limits are given in the respective NIOSH criteria documents [32,33]. Recommendations for entering, working in, and exiting from, confined spaces are given in the NIOSH criteria document Working in Confined Spaces [34]. Adherence to these recommendations will protect health and significantly reduce accidental injury and death associated with entering, working in, and exiting from confined spaces. It will also make the worker cognizant of the hazards associated with his work area and the safe work practices necessary to deal with these hazards.

(b) Infectious Diseases

Although infectious diseases have not been a major hazard in rendering plants in the United States, a few cases of brucellosis, psittacosis, Q-fever and anthrax have been reported. The agents for these diseases are introduced into the rendering environment by infected animal carcasses, but the rendered product is expected to be free of the disease agents because of the high temperature involved in the process. If infection with a zoonotic agent does occur, early diagnosis and treatment will tend to limit the duration and severity of the disease.

Brucellosis is a zoonotic disease transmitted by direct contact with diseased animals (cattle, swine, sheep, goats, horses, and reindeer), by conjunctival exposure, airborne droplet exposure, and ingestion of contaminated material. Brucellosis is characterized by malaise, chills, sweating, body aches, headache, loss of appetite, weight loss, and a fever of 101-104 F (38-40 C). Brucellosis has a fatality rate of 2%, and death is rare in persons with antibiotic treatment. Untreated cases may become chronic [35-37].

In the last 3 years for which data are available, independent rendering plant workers constituted 1.1% (3 of 271) of the brucellosis cases in the United States in 1976 [38], 1.7% (3 of 176) of the cases in 1977, and 5% (8 of 161) in 1978. Other cases may occur among the rendering workers of meat packing plants, but no details are available (M Potter, verbal communication, February 1979; A Kornblatt, verbal communication, February 1981).

Psittacosis is an infectious disease transmitted by direct contact with infected birds (eg, turkeys and pigeons) or the inhalation of dust from their droppings. This disease is characterized by an abrupt onset of shaking, chills, fever, headache, backache, photophobia, and loss of appetite [33-35]. Complications may result, but recovery is the usual outcome. Fatality is rare.

In 1961 and 1973, Langmuir [39,40] reported on 26 cases of psittacosis among 38 workers (68.4%) of an independent rendering plant in Portland, Oregon, during the winter of 1955-1956. Infected turkeys had been chopped into small pieces and blown through a large duct into a vat for steam-pressure cooking. The disease occurred in workers in all job categories in the rendering plant except the truck drivers. The author [40] suggested that the disease was transmitted by the infective aerosol produced by the chopping and blowing of the infected material.

Q-fever is a zoonotic disease transmitted by direct contact with infected animals (eg, cattle, sheep, goats) or the inhalation of dust from their droppings. This disease is characterized by chilly sensations, retrobulbar headache, weakness, malaise, and severe sweating [35,36]. Pneumonitis occurs in most cases, with mild cough and chest pains. The fatality rate of untreated patients is less than 1%, and, for patients treated with antibiotics, it is negligible.

In 1947, Topping et al [41] reported an outbreak of Q-fever among workers in a cattle and hog meatpacking plant in which rendering was also performed. Of 97 workers, 31 (32%) had Q-fever, including 3 of the 4 workers in the lard and tankage areas associated with the rendering process. These workers also assisted in the slaughtering process; therefore, the area of the plant where the infection was acquired could not be established. Three of five workers in the hide-curing area also developed the disease. The remaining cases occurred in the slaughtering and dressing, boning, and sausage areas. The authors concluded that handling the tissues of freshly slaughtered animals in a meatpacking plant can carry a high risk of Q-fever infection.

Anthrax is a zoonotic disease transmitted by the inhalation of spores shed by infected animals (eg, cattle, sheep, horses, and pigs) or by direct contact with the animal. This disease is characterized by headache, nausea, vomiting, and fever [35,37]. Untreated cutaneous anthrax has a fatality rate of 5-20%; with effective antibiotic therapy, however, there are essentially no deaths.

The first case of human anthrax since 1955 was recorded in September 1980 in Colorado. It occurred in a 30-year-old man who had worked with animal carcasses. The man had assisted in skinning animal carcasses at a local rendering plant from August 26-31, during which time he was scratched on the arm by an animal hoof. A lesion and swelling developed; B anthracis was isolated from a wound culture. Surveillance of other workers at this plant has yielded no other cases in humans [42].

Other zoonoses, such as leptospirosis, could presumably occur in rendering plant workers; however, no cases of this disease have been reported in the United States. Several measures can reduce the risk of transmitting these infectious diseases in rendering plants. These include frequent washing of the hands, the provision of separate eating areas, and provision of ventilation control to isolate airflows from raw material or processing areas into final product areas. Wounds should be thoroughly cleaned and receive prompt first aid. Since minor cuts are relatively common in the rendering industry, tetanus immunizations should always be current.

Work areas in rendering plants should have conveniently located handwashing facilities with bowls large enough to minimize splashing. These areas should be supplied with hot and cold running water and should be directly connected to the drainage system. Smoking and eating in work areas of edible-rendering plants is prohibited by the US Department of Agriculture.

(c) Chemical Irritants Affecting the Skin, Eyes, and Mucous Membranes

Chemicals are used in rendering plants mostly for cleaning, to process animal material, treat waste water, and control odors, and in cooling towers and boilers (Table I-1). However, workers are usually only exposed to the chemicals used for cleaning, deodorizing, and water treatment. Generally, these chemicals are alkalies or oxidizing agents and may cause chemical burns or irritation. Inhalation of these agents may result in lung irritation and injury. Skin contact may result in dermatitis.

Injuries from mixing, storing, and applying these chemicals can be prevented if workers are trained to use personal protective equipment and the proper methods of handling chemicals. Full-face shields over chemical splash-type goggles, rubber gloves, rubber boots, rubber aprons, or rubber suits are examples of equipment that may be required. Where workers do their jobs in the presence of vapors or dust, there must be adequate ventilation. This may include a combination of general air ventilation and local exhaust ventilation. Respirators must be available for emergency protection where toxic vapors may be generated from some of the chemicals used in rendering plants (eg, chlorine). If a job requires a respirator, the employer must ensure that the worker is thoroughly trained in its use. Workers should be capable of and responsible for testing for leakage, proper fit, and proper operation of respirators.

If chlorine or other toxic chemicals are used in a rendering facility, special engineering controls and work practices may be necessary. Details concerning safe work practices and engineering controls are presented in the chlorine criteria document [43].

The employer should ensure that all compounds are used only in proper concentrations and in ways suitable for their intended purposes. Procedures must be established for mixing chemicals as recommended by the manufacturer or as developed by qualified plant personnel. In addition, employers should be familiar with all chemicals used, including their physical properties and any associated hazards. They must ensure that chemicals are kept in designated storage areas and that their use is accompanied by proper recordkeeping. Containers of chemicals should be tightly sealed and stored in a dry place. All chemical containers must be labeled.

As indicated in Table I-1, hydrazine may be used as an oxygen scavenger in boiler systems. Hydrazine deserves special attention because it may be absorbed through the skin, is toxic, and is judged by NIOSH to be a potential human carcinogen. A recommended standard, including work practices, is presented in the hydrazine criteria document [44]. Because other oxygen-scavenging chemicals may be used to remove oxygen, the use of hydrazine is unnecessary in rendering boiler systems (W Prokop, written communication, March 1979).

(d) Allergens

Rendering plant workers are exposed to a variety of animal danders, including those of the hair, skin, feathers, and other animal materials. Exposure to airborne animal-dander particles may result in asthma, inflammation of the nasal mucosa, and conjunctivitis. A scratch by a part of a carcass can cause a pruritic wheal and flare response (urticaria) at the site of contact. No data are available to assess the effects of worker exposure to allergens in rendering operations.

III. HEALTH AND SAFETY GUIDELINES

NIOSH has formulated these guidelines as a result of this study. These recommendations apply to workers who render animal materials, which includes the use of heat or mechanical means to reduce fat-containing tissues, bones, and whole carcasses, the reclaiming of grease, and the production of blood and feather meal. These recommendations also apply where dead stock is skinned, gutted, and boned and hides are trimmed and processed. They are not intended for workers who reduce marine raw materials because of differences in the process, raw material, and finished product.

Engineering Controls

Engineering controls are the preferred approach to minimize the hazards from lifting, pushing, and pulling large and heavy containers and carcasses, excessive noise, wet and slippery surfaces, grease and fat buildup, unguarded process equipment, dust exposure, and potential toxic gas buildup in confined spaces. NIOSH recommends engineering controls to minimize the following hazards in rendering plants.

(a) Lifting

A program should be instituted to identify hazardous lifting jobs.

(1) All manual lifting jobs should be classified according to the criteria set forth in NIOSH's Work Practice Guide for Manual Lifting.

(2) Manual lifting tasks classified between the action level (AL) and the maximum permissible level (MPL) require either administrative or engineering controls; lifting tasks above the MPL require engineering controls such as cranes and hoists [19].

(b) Pushing and Pulling

A program should be instituted to identify hazardous pushing and pulling jobs.

(1) Engineering controls such as hoists, conveyors, hand trucks, and automatic barrel decanters should be considered when frequent pushing or pulling is a part of any job.

(2) If mechanical conveying devices are not available to minimize hazardous pushing and pulling, the layout of work stations in the plant should be planned to minimize the distance objects have to be transported. For example, drums should be unloaded as close as possible to processing operations.

(c) Noise

The employer should be aware of the Federal regulation (29 CFR 1910.95) that protects workers against the effects of noise exposure.

(1) To reduce noise exposure, techniques such as preventive maintenance, using proper operating speed, choosing appropriate equipment locations, and simple machine treatments (eg, vibration isolation or control) should be considered first.

(2) Other forms of noise control, such as shields and barriers, should be considered when these other measures are inadequate.

(3) NIOSH's Industrial Noise Control Manual, the United Auto Workers' Noise Control (Workers' Manual), OSHA's Noise Control Manual, and other similar publications should be consulted [21,45,46].

(d) Heat and Air Contaminants

A program should be instituted to periodically identify any heat, humidity, or air contaminant problems in the plant.

(1) Ventilation systems are recommended for controlling these problems.

(2) Ventilation control of fat and grease emissions is recommended when the buildup of these materials makes walking and working surfaces hazardous.

(3) Ventilation control of fat and grease emissions is recommended when the buildup of these materials in the plant creates a fire hazard.

(4) Local exhaust ventilation is recommended when general ventilation does not adequately control these hazards.

(5) Ventilation and/or air-conditioned enclosures should be provided in areas considered to be hot environments.

(6) Ventilation systems should be designed to prevent air movement from raw material or processing areas to final product areas.

(7) Ventilation systems should be subjected to regular cleaning and preventive maintenance to ensure their continued effectiveness.

(8) Ventilation systems discharging into the outside air should conform to applicable local, state, and Federal air pollution regulations.

(e) Machines and Conveyors

Guarding of machinery and power transmission equipment in a rendering plant should provide the maximum degree of protection to the workers.

(1) Machines and power transmission equipment can be guarded with barriers, or be isolated.

(2) Screw conveyors should be fully covered or guarded so that neither workers nor their clothing can contact moving parts.

(3) Federal regulations (29 CFR 1910.219) exist which require mechanical power-transmission equipment (shafts, gears, pulleys, etc) within 7 feet (2.1 m) or less of the floor or of work platforms be covered or guarded.

(f) Working in Confined Spaces

Ventilation, as described in the NIOSH criteria document Working in Confined Spaces [34], is recommended for all confined space work. Installation of a ventilation system (eg, fans) for a confined space, where outside air is introduced and stagnant air is exhausted, will help prevent accumulation of any toxic gases.

(g) Walking-Working Surfaces

Walking-working surfaces should receive attention to minimize the number of accidents involving them.

(1) Walking-working surfaces should be slip-resistant.

(2) Worn walking-working surfaces that have lost their slip-resistant characteristics should be replaced or refinished.

Work Practices

(a) Walking-Working Surfaces

Injuries caused by unsafe working surfaces can be reduced by minimizing the accumulation of grease or fat on floors, and by following the guidelines below:

(1) Working surfaces, such as floors, platforms, and stairs, shall be kept clean and orderly. Federal regulation 29 CFR 1910.22 requires aisleways and passageways be kept clear, dry, and in good repair.

(2) All elevated platforms, pits, and stairways should be guarded. Pits receiving raw material should be guarded on all sides. If necessary, guards may be removable on not more than two sides. The employer should be aware of the Federal regulations (29 CFR 1910.23-1910.24) that exist for the guarding of floor and wall openings, holes, and stairs.

(b) Hand-Held Equipment

The use of hand-held equipment can be hazardous in rendering tasks [13]. Compliance with the following recommendations will reduce the number of injuries associated with hand-held equipment.

(1) Personal protective equipment such as mesh gloves, abdominal protectors, and arm guards should be worn by workers for hide removal and any carcass cutting operations.

(2) The employer should be aware of the Federal regulations (29 CFR 1910.241-1910.247) that protect the worker against the hazards of hand and portable powered tools. Subsections of 29 CFR 1910.243 entitled "(a) Portable powered tools" and "(b) Pneumatic powered tools and hoses" are specifically relevant to rendering processes.

(3) Employers should ensure that knives with hand guards are used in all carcass cutting and hide removal procedures.

(4) Employers should ensure that workers using knives are provided with scabbards and are instructed in their proper use.

(5) Employers should ensure that electric hand tools are properly grounded when in use.

(6) Employers should ensure that all hand-held electrical tools with pressure switches (deadman controls) are considered for use.

(c) Emergency Procedures

When emergency procedures are established and practiced, prompt and effective action is facilitated, and the adverse effects of an emergency can be minimized. Emergency procedures in rendering plants should include plans such as those described below.

(1) Fires, Chemical Leaks, Electrical Malfunctions, and Evacuation

(A) Personal protective equipment and protective clothing should be used by personnel during emergency operations. Respirators should be placed at readily accessible and clearly labeled locations.

(B) Workers not engaged in correcting the emergency should be evacuated from hazardous areas. The perimeters of these areas should be posted and secured.

(C) Only those personnel trained against the attendant hazards should control and repair leaks and fight fires.

(D) Firefighting procedures should be established for areas where flammable materials are used. Requirements for fire protection are stated in 19 CFR 1910 Subpart L (156-165).

(2) Administration of First Aid

(A) At least one person per shift in each rendering facility should be trained and certified in first-aid procedures. As a minimum, training should include proper treatment for slips and falls and emergency care of eye injuries, burns, and wounds.

(B) All workers having wounds should be treated immediately to prevent blood poisoning, and should wear impervious gloves or otherwise dress the wound to prevent infection (unless counseled otherwise by the responsible physician).

(c) Suitable Eyewash Fountains

Federal regulation 29 CFR 1910.151, Paragraph (C), requires suitable facilities for quick drenching or flushing of the eyes where skin or eye contact with caustic or corrosive chemicals may occur.

(3) Assistance for Injured Workers

Immediate evacuation, transportation, and medical assistance should be available for injured workers. This should include alerting the medical facility of the impending arrival of injured workers.

(4) Medical Facilities for Emergencies

All workers should be told which medical facilities are designated for use by plant personnel for job-related injury or illness.

(5) Entry into Areas for Cleanup, Decontamination, or Maintenance Following Release of Toxic Materials

(d) Laundering

Frequent laundering of soiled work clothing is a generally accepted practice demonstrated to be effective in industries that are associated with the use of chemicals or other agents that may irritate skin or be toxic through dermal absorption. The harmful effects of these agents can be exacerbated by prolonged contact. Soiled work clothing should be laundered frequently, and the employer should ensure that clean work clothing is worn daily.

(e) Materials Handling and Storage

Accidents involving powered industrial trucks have been recorded [13], and many of them could have been prevented by the following.

(1) The employer should be aware of the provisions of 29 CFR 1910.176-1910.190, which protects the worker against the hazards associated with materials handling and storage. Sections 176, 178, and 184, which address materials handling, powered industrial trucks, and slings, are especially relevant to rendering plants.

(2) Employers should prohibit operators of front-end loaders or forklift trucks from raising or lowering the loader or forks while the vehicle is in motion in the plant.

(3) Workers should operate forklifts with their load raised only enough to clear the driving surface.

(f) Maintenance

Many problems occurring in rendering plants could be prevented by adhering to the following recommendations.

(1) A regular preventive maintenance program should be established to avoid fires and excessive noise generation that results from inadequate lubrication, misaligned bearings, and improperly adjusted belt-driven machinery.

(2) All equipment, including valves, fittings, and connections, should be checked regularly for tightness and kept in good working condition. Inspections should be made immediately after new connections are made and after material is introduced.

(3) Leaking steam lines should be repaired promptly.

(4) Whenever maintenance work is to be performed, standardized safety procedures should be followed. These procedures should include adherence to NIOSH's recommendations for hazard control during maintenance [20], the use of protective equipment, and the proper selection and use of hand tools.

(5) Maintenance work in a confined space should adhere to the recommendations of the NIOSH criteria document, Working in Confined Spaces [34].

(g) Entry into Confined Spaces

When cleaning, maintenance, and repair of rendering equipment require entry into a confined space, the recommendations in the NIOSH criteria document should be adhered to. These recommendations include the following [34].

(1) The employer shall designate in writing a person qualified by education or specialized training to anticipate, recognize, and evaluate worker exposure to hazardous substances or other unsafe conditions in a confined space. This person shall be authorized to specify necessary controls and protective actions to ensure worker safety.

(2) Entry into a confined space shall be by permit only. The permit shall be an authorization and approval in writing that specifies the location and type of work to be performed. It should also certify

that all existing hazards have been evaluated by the qualified person and that necessary protective measures have been taken to ensure the safety of each worker.

(3) The designation of a confined space shall be based on the existing or potential hazards associated with it.

(4) Entry into a confined space shall be prohibited until the atmosphere has been initially tested from the outside and found to be safe. The tests to be performed should include those for oxygen deficiency, flammability, and, if appropriate, toxic materials.

(5) The entry permit shall include a list of protective equipment necessary for work in the confined space, as determined by the qualified person.

(6) All workers associated with confined space entry shall be trained in the use of the appropriate personal protective equipment.

(7) The need for respiratory protection shall be determined by the qualified person based on conditions and test results of the confined space and on the work to be performed.

(h) Waste Disposal

Local, state, and Federal regulations recognize the need for proper waste disposal in maintaining community health. Waste material should be disposed of in a manner not hazardous to plant personnel, and these disposal methods should conform to applicable local, state, and Federal regulations.

(i) Sanitation and Personal Hygiene

Some biological agents and chemical substances found in rendering plants can harm exposed workers. Adherence to the following guidelines will minimize these exposures.

(1) Federal regulation 29 CFR 1910.141 requires plant sanitation. Subsections entitled (a) General, (c) Toilet facilities, (d) Washing facilities, (e) Change rooms, and (g) Consumption of food and beverages on the premises are especially relevant to rendering processes.

(2) Workers should be instructed by their employer to wash their hands with soap and water as frequently as practicable. As a minimum, workers should be encouraged to wash their hands during all workbreaks, before eating, and before and after using toilet facilities.

(3) Preparing, storing, dispensing (including vending machines), and consuming food or beverages should be prohibited in work areas.

Medical

Preplacement medical examinations should be made available to all workers engaged in rendering processes so as to identify existing conditions that might predispose a worker to injury or illness. Subsequent periodic medical examinations provide for the reassessment of health and physical fitness in relation to possible job stress or hazards. Tetanus vaccination and boosters, unless current, are recommended because of the risk of cuts and puncture wounds. The medical surveillance program should include the following.

(a) Preplacement Examinations

These examinations should include at least:

(1) A request that the employer provide pertinent information to the responsible physician, such as an estimate of the worker's potential exposure (including any available workplace sampling results), and a description of any protective devices or equipment the worker may be required to use.

(2) Comprehensive medical and work histories with special emphasis on allergies and the musculoskeletal system.

(3) Physical and job fitness examinations giving particular attention to the skin, eyes, back, and respiratory system.

(4) A tetanus vaccination that subsequently should be made available on an appropriate routine schedule.

(5) A judgment of the worker's ability to use negative- and positive-pressure respirators.

(6) Baseline audiograms when exposures to noise are judged to possibly exceed Federal limits.

(7) A written statement specifying any limitations that should be placed on the worker's job function (prepared following completion of the examination by the examiner).

(b) Periodic Examinations

These examinations should be made available at least every 3 years, and include at least:

(1) Reassessment of health and job fitness.

(2) Physical examination and procedures outlined in paragraphs (a)(2), (a)(3), (a)(4), and (a)(7) above.

(3) Listing of any limitations that should be placed on the worker's job function.

(c) Audiometric Testing

An audiometric testing program should be made available for workers who may be exposed to noise that exceeds 85 dBA for an 8-hour workday.

(d) Maintenance of Medical Records

Pertinent medical records should be maintained for all workers exposed to hazards in rendering plants. Records of environmental exposures to physical or chemical agents of a worker should be included in his or her medical records. Such records should be kept for at least 5 years after termination of employment.

Personal Protective Equipment and Work Clothing

Although engineering controls are the most effective means of minimizing hazards (such as noise, heat, slippery working surfaces, and confined spaces), personal protective equipment and work clothing are necessary to back up those engineering controls. The following guidelines are recommended.

(a) Safety shoes or boots with toe guards and slip-resistant soles should be worn at all times.

(b) Personal protective equipment, such as ear protectors, should be provided and used if noise controls fail to reduce sound levels to or below limits recommended by NIOSH. Ear plugs should be individually fitted to provide proper protection.

(c) The employer should ensure that appropriate clothing is worn by all workers.

(d) In designated areas, safety helmets meeting specifications in ANSI Z89.1-1969 should be worn.

(e) Mesh gloves, abdominal protectors, arm guards, and other protective equipment should be worn to remove hides and cut carcasses.

(f) Workers using chemical compounds in rendering operations should use gloves resistant to that particular compound.

(g) When respirators are needed, the employer should be aware of the Federal regulation (29 CFR 1910.134) and the American National Standard Institute recommendation (ANSI Z88.2-1969) that protect the worker against the effects of atmospheric contamination.

Posting

Workers should be apprised of hazards in rendering facilities and of methods to protect themselves. Although all who work in rendering facilities should receive such training prior to placement, signs serve as important reminders. Signs are also an initial warning to workers not familiar with the facility, such as contractors, delivery people, and others.

(a) Signs should be printed in English and in the predominant language of non-English-reading workers. Workers unable to read these signs should in some manner receive all necessary information regarding hazardous areas and should be informed of the instructions printed on these signs.

(b) Signs should be kept clean and readily visible at all times. In rendering work areas, signs should be posted where applicable. The information may be arranged as in the following examples.

SAFETY HAT AREA
DO NOT ENTER
WITHOUT APPROVED HARD HAT

NOISE EXPOSURE AREA
HEARING PROTECTION REQUIRED

CAUTION
SLIPPERY FLOORS
PROCEED WITH CAUTION

EYE PROTECTION REQUIRED
DANGER
GREASE AND ELECTRICAL FIRE HAZARD
AVOID OPEN FLAMES, EXCESSIVE HEAT, AND SPARKS
IN CASE OF FIRE, USE CHEMICAL EXTINGUISHERS

WARNING
OPEN PIT
PROCEED WITH CAUTION

DANGER
HAZARDOUS AREA
PERMIT REQUIRED FOR ENTRY

If respiratory protection is necessary, the following statement, in large letters, should be added to any other information on a sign.

RESPIRATORY PROTECTION REQUIRED IN THIS AREA

Training Workers and Informing Them of Hazards

Companies with superior safety performances have safety evaluation programs that anticipate and manage potential hazards. These companies have a strong management commitment to safety, are characterized by a safety program integrated into the larger management system, and they deal with safety as an intrinsic part of plant operations [47].

Training should be repeated at least annually to reinforce established safe work practices and to update worker knowledge of changes in work practices, personal protective equipment, and process modifications.

The employer should:

(a) Ensure that workers can perform their assigned tasks safely before allowing them to participate in a rendering operation without direct supervision.

(b) Ensure that a continuing training program is conducted at least annually that includes formal instruction by persons qualified by training or experience.

(c) Ensure that at least one person on each shift is trained and certified in first aid. First-aid training should include, as a minimum, completion of an approved first-aid training course.

(d) Ensure that workers are informed both orally and in writing of the safety rules established at their rendering facility. Those rules should provide safe standard operating procedures for all activities performed in the plant. Workers should also be informed orally of the hazards of each rendering operation.

(e) Ensure that all new workers are trained in at least these five subjects.

(1) The specific job function of the worker.

(2) The general hazards of the rendering plants, including potential sources of mechanical injury and effects of excessive heat and noise, chemicals, decomposition gases, and infectious agents.

(3) The proper use and maintenance of protective equipment, including respirators, when applicable.

(4) Correct housekeeping practices.

(5) Emergency procedures for fires, chemical leaks, electrical malfunctions, and evacuation of disabled workers.

(f) Ensure that selected workers on each shift also receive training in first-aid procedures, firefighting, chemical leaks, and entry into confined spaces.

Industrial Safety and Health Surveys and Monitoring

To ensure that workers are not exposed to hazardous conditions, the workplace should be surveyed periodically. Industrial safety and health surveys should be conducted according to the following guidelines.

(a) The surveys should determine the adequacy of: illumination in all areas of the plant; guarding for pits, elevated platforms, stairs, and machines and other process equipment; general and local exhaust ventilation; electrical wiring and equipment; noise control; heat control; fire prevention and steam line insulation; chemical storage procedures; posting of information; general plant sanitation; personal protective equipment; training programs; and recordkeeping.

(b) Industrial safety and health surveys should identify where workers are exposed to hazardous conditions. If the employer concludes that there are no areas where exposure to hazardous conditions occurs, the records should state the basis for this conclusion. Surveys should be repeated at least annually and within 30 days after any process change likely to create a hazard.

(c) If it has been determined that exposure to hazardous conditions exists, the employer should institute a program of personal monitoring to identify and measure, or to permit calculation of, the exposure of each worker. Source and area monitoring might be used to supplement personal monitoring.

(1) In all personal monitoring, samples representative of exposure in the breathing zone of the worker should be collected. All noise measurements should be made with the sound-level meter or noise dosimeter in a location closely approximating the noise levels at the worker's head during normal operations.

(2) If a worker is found to be exposed to hazardous agents exceeding recommended limits, his or her exposure should be measured frequently, control measures should be initiated, and the worker should be notified of the exposure and control measures. Accelerated monitoring should be considered until results indicate that the control measures are effective and that the worker's exposure no longer exceeds the recommended occupational exposure limit. Routine monitoring may then be resumed.

(d) Some occupational hazards in the rendering process, primarily those related to safety, cannot be monitored as discussed above. When such hazards are identified in the industrial safety and health survey, the employer should notify workers of the hazardous condition, post the area, and initiate corrective action. Increasingly frequent safety surveys should be considered until the hazardous condition is corrected.

Recordkeeping

Accurate recordkeeping of surveys, medical examinations, and other pertinent material will enable the employer to assess the efficiency of the plant's control program.

(a) These records should be kept for at least 5 years after termination of employment.

(b) Records should include: identification of the worker being monitored; duties and job locations within the worksite, times and dates of sampling and analytical methods used, and available evidence of their precision and accuracy; the number, duration, and analytical results of samples taken; and personal protective equipment used by the worker. Records of safety surveys should clearly identify and describe any hazardous condition and state the corrective action taken.

IV. WORKER TRAINING AND EDUCATION

Because rendering operations involve potential hazards to safety and health, proper training and education of workers is vital. A comprehensive, well-organized training program enables the employer to educate new workers in safe work practices and techniques from the beginning of their employment. Such training helps to establish a positive employer-worker relationship by demonstrating the employer's concern for, and commitment to, safe work practices.

Training Methods, Need and Frequency, Evaluation, and Objectives

(a) Methods

Workers can be trained most effectively while on the job. Qualified personnel explain and demonstrate part of the task, and then the worker is allowed to do it. As the worker develops proficiency, other work segments may be added. Each new step requires close supervision until the worker is judged competent to perform his tasks proficiently and safely.

(b) Need and Frequency

The employer must ensure that all workers can perform their intended tasks safely before allowing them to work in rendering operations without immediate supervision. The need and frequency for additional training will vary depending on the individual, the complexity of the task, and the nature of the operation's hazard. First-line supervisors may be the best judges of when and in what areas workers need additional training, because they can observe the workers frequently and be familiar with their work habits and performance. These supervisors are also likely to be best able to suggest how worker accidents might be minimized, since they usually have first-hand knowledge of the circumstances.

(c) Evaluation

Evaluations of worker safety performance should be conducted by first-line supervisors who are best able to discern whether workers adhere to established work practices and safely perform their particular tasks. Written tests or check sheets may be used in conjunction with training and evaluating procedures. The success of the training program depends on participation and positive motivation by management.

(d) Goals

Specific goals should be established for each problem area in operations for which training is offered, including the following:

(1) The worker should know that a leading cause of accidents in rendering operations are unsafe walking-working surfaces. Workers should

know that the frequency of slips and falls can be reduced by using proper floor materials and footwear. Workers should be aware of special hazards associated with unguarded pits and elevated work stations in rendering operations.

(2) In the training program, the worker should be warned that hand tools are a major source of injury in rendering operations, especially where whole carcasses are cut with knives or axes, and in many maintenance operations. The worker should understand the purposes of the protective devices available, which, if used properly, will minimize or eliminate injuries. The worker should know how to properly select and fit mesh gloves, arm guards, and protective aprons. They should understand that properly used mechanical aids to lift or transport objects can help reduce the incidence of injury. If manual lifting is necessary, a job analysis should be performed before any lifting is done. The worker should be fully aware that the use of these techniques will minimize the chances of strains, sprains, and other injuries.

(3) Workers should be given safety orientation, in which potential hazards in the rendering facility are pointed out, eg, hot process equipment, electrical equipment, confined spaces, and chemical storage areas. The worker should know the hazards associated with each chemical he uses and the proper procedures for handling such materials. He should also know the signs and symptoms associated with illnesses that might result from contact with infectious agents in his rendering operation, and know how these diseases can be transmitted.

(4) Workers should know emergency plans and procedures for firefighting, cleaning up chemical leaks, and entering confined spaces. Workers who use respiratory protective equipment should know how to use and maintain it.

(5) Workers should know where to obtain first aid.

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VI. APPENDIX

GLOSSARY OF TERMS USED IN RENDERING INDUSTRY

Blood meal -	A protein product consisting of dried blood solids.
Centrifuge -	Machine using centrifugal force for separating materials of different densities.
Continuous rendering -	This is synonymous with continuous cooking. The raw material is fed continuously to the cooking device, and the cooked material discharges essentially at a constant rate.
Cooker, batch -	Horizontal, steam-jackated cylinder equipped with a mechanical agitator. The batch cooker follows a repetitive cycle: it is charged with the proper amount of raw material, dehydrates this material and finally discharges the cooked material.
Cracklings -	Solid protein material discharged from screw press after removal of liquid fat.
Crusher, Grinder, Hogger, - Pre-breaker, etc.	Machine containing blades or knives which reduce raw material to a relatively uniform size.
Edible fat -	Fat taken from edible parts of the animal.
Fat products -	Inedible tallow or grease.
Feather meal -	Protein product also known as hydrolyzed poultry feathers.
Grease -	A fat product with a titer less than 40.0 degrees centigrade.
Hydrolyzed -	Chemical reaction with water to break down the indigestible protein of poultry feathers into a digestible form.
Lard -	A fat obtained by rendering the fat removed from various edible tissues of pigs (hogs).

Meat-and-bone meal -	Dry rendered protein product from mammal tissues with more than 4.4% phosphorus.
Meat meal -	Dry rendered protein product from mammal tissues with 4.4% or less phosphorus.
Offal -	All material from the animal's body cavity used for inedible rendering.
Pressure leaf filter -	Machine for removal of solids from liquids where a filter cloth mounted on a series of leaves or plates is capable of accumulating a solid cake as pressure is applied continuously.
Raw material -	All material from animal and poultry sources used for inedible rendering.
Rendering, dry -	The process of releasing fat by dehydrating raw material in a batch cooker or continuous rendering system with no direct addition of steam or water.
Restaurant grease -	A waste fat material obtained primarily from fast food restaurants.
Screw press -	Machine used to separate fat from tankage continuously by applying the required pressure with a rotating screw.
Tallow -	
Inedible Tallow	Fat obtained from the inedible body tissues of cattle and sheep. Animal fat product with a titer of 40.0 degrees centigrade or higher.
Edible Tallow	Fat obtained from the edible parts of cattle and sheep.
Tankage -	Cooked material remaining after the liquid fat is drained and separated.
Titer -	An analytical measurement used to indicate the hardness or softness of fats. It is expressed in degrees centigrade.
Wet scrubber -	Pollution control device for contacting air exhausted from rendering plant with a water solution containing deodorizing chemicals.
Zoonotic disease -	A disease that can be transmitted from animals to man.

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